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The interoceanic ship canal;(papers, etc

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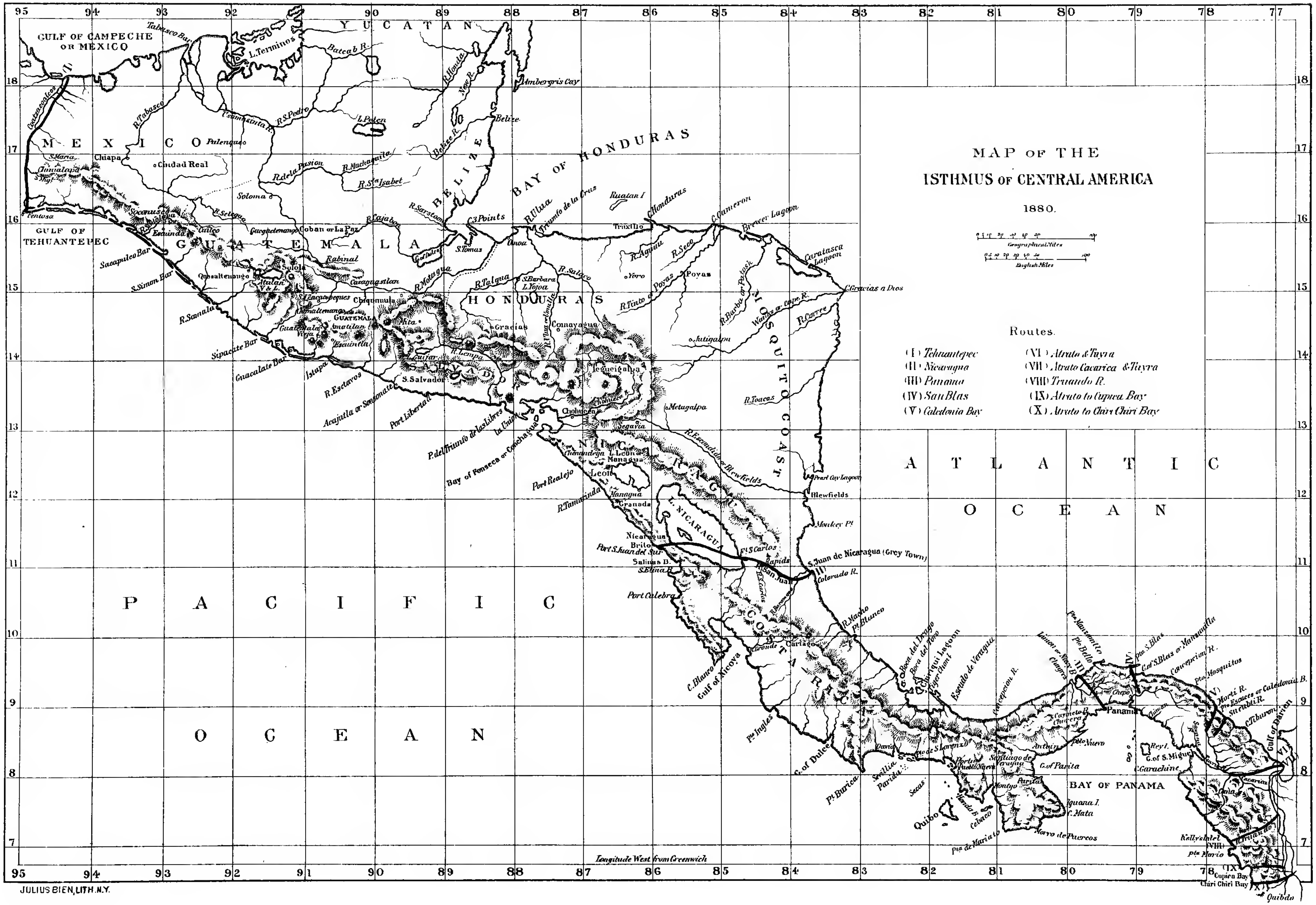

JULIUS BIEN, LITH. N.Y.

THE INTEROCEANIC SHIP CANAL.

MEETING AT CHICKERING HALL.

December 9, 1879.

PAPER BY REAR-ADMIRAL DANIEL AMMEN, U. S. NAVY,

Representative of the United States in the Congress at Paris on

THE PROPOSED INTEROCEANIC CANAL ACROSS NICARAGUA.

Addresses by CHIEF-JUSTICE DALY, and A. G. MENOCAL, Chief-Engineer, U. S. Navy.

Letters from FREDERIC M. KELLEY, WALTON W. EVANS, C. E., and NATHAN APPLETON.

Report on the Proceedings of the Congress in Paris, in May, by Rear-Admiral DANIEL AMMEN, U. S. Navy (See Appendix A).

Views of WALTON W. EVANS on the proposed Canal between North and South America, dated May 9, 1879, and addressed to M. C. AUGUSTE VON HERNERT, for submission to the Paris Congress.

Report of W. E. JOHNSTON, M. D., Delegate of this Society to the Paris Congress, dated August 15, 1879, on the Proceedings of the Congress.

THE NICARAGUA CANAL: Extract from Mr. S. B. RUGGLES's Semi-Centennial Address at New Haven, July 27, 1864.

Among the prominent gentlemen upon the stage were Chief-Justice Daly, A. G. Menocal, C. E., Signor de Franco, General George W. Cullum, U. S. A., Francis A. Stout, William Remsen, Harlow M. Hoyt, William H. Webb, William H. H. Moore, General Egbert L. Viele, Colonel T. Bailey Myers, James T. Gardner, Director of the New York State Survey, Elial F. Hall, John E. Body, and Sidney F. Shelbourne.

The formal business of the evening having been disposed of, the President introduced Colonel T. Bailey Myers, of the Council, who, at the request of Admiral Ammen, read his paper—the principal topic of the evening.

THE PROPOSED INTEROCEANIC SHIP CANAL ACROSS NICARAGUA.

BY

REAR-ADMIRAL DANIEL AMMEN, U. S. NAVY.

[In the absence of the author, this paper was read by Colonel T. Bailey Myers, who briefly referred to the topic as follows :]

Ladies and Gentlemen—In fulfilling a duty devolved upon me by Admiral Ammen, I regret that he could not have been here in person. An accidental association some years since as members of the Board of Visitors at the Naval Academy, ripening into friendly relations and correspondence, probably induced him to select me to represent him. With no personal interest in the enterprise, I have the highest opinion of his capacity and the value of his opinion. His paper was forwarded before the opening meeting, but was deferred to that of Lord Dunraven, who was in haste to leave the country. It seems proper to make an explanation on behalf of the Council of the position of the Society on the Interoceanic Canal question. Its Hall and Journal have been open for years for its discussion. Foreseeing that all attainable information on the subject would soon be necessary, a committee of the Council, consisting of Mr. Clarence King (Director of the United States Surveys), Mr. Francis A. Stout (Commissioner for the New York State Survey), and myself, by memorial and personal attendance at Washington, urged Congress, last winter, to print the surveys and statistics connected with the Government work on the Panama and Atrato-Napipi routes executed long before. This was only completed in a temporary form in time for the use of the Congress at Paris, and has recently been officially published. Access to it could not be had by the Society before that time, and was refused to individuals. In sending representatives to that Congress, the Society, therefore, claimed to take no part in the decision of an important question, of the merits of which, for these reasons, they could be but partially informed, but only as an appreciation of its importance, and to acquire information. Naturally they could not express an opinion without the time for study of prior details, nor could they expect that their representatives, during its brief and exciting session, should become able to do so. Two of these representatives have since given to the public their conflicting views on the plan presented by M. de Lesseps—Dr. William E. Johnston, residing in Paris, by his able written report to our President, Chief-Justice Daly, received in the vacation, and Mr. Nathan Appleton, in reading at about the same time a paper before the Board of Trade, supplemented by a communication to be read this evening.

Admiral Ammen, as Chief of the Bureau of Navigation, having been charged with the fitting out of the American explorations, and as a member of a commission formed by the Government for the consideration of its plans, having studied their results, has labored under no such difficulties. Those who know his capacity and devotion to every duty will believe his to be of the greatest value as an educated opinion. Knowing that other conclusions will be advanced, he has authorized me to say that he is prepared to sustain it, and to reply to them if brought to his attention in the public press, that he considers the subject worthy of exhaustive, if competent, discussion.

Of one so important, those present will, it is hoped, patiently submit to an extended discussion, caused by a desire to entertain all opinions, and open its merits to a free investigation. I will now read Admiral Ammen's paper.

THE PAPER.

I am indebted to a prominent member of your Society for the suggestion that I should continue the discussion of the Interoceanic Canal question under its auspices.

I propose for your examination, "The Present Aspect of the American Interoceanic Canal Question."

I shall not tire the patience of my hearers by an attempted history of this subject; those who are desirous to inform themselves as to what was known and what was asserted prior to 1866, can do so by reading a Report to Congress by Rear-Admiral Davis, U.S.N., published that year under the title of "Interoceanic Railroads and Canals," of course referring to this continent. It contains from pages 31 to 37 the authorities cited; a large amount of valuable information necessarily interspersed with much that is wholly unreliable, or only of partial value. The elimination of mere assertions and of errors has added vastly to the work of exploration and survey since that time. For an outline as to what has been done since then, I may refer you to my paper of Oct. 31, 1876, and a second, read Nov. 15th, 1878, before your Society.

The first paper was intended to show the errors of M. Drouilet, French engineer, and those who regarded him as an authority, as shown in a pamphlet issued in Paris in May, 1876, apparently with the approval of the commercial branch of their Geographical Society. It was designed to show that there did not exist unknown routes comparable for the construction of a ship canal to those already known. The second paper was to show the feasibility of a ship canal via Nicaragua as a commercial question, and to do this it seemed to me necessary to establish its superiority over all known points, especially as to economy of construction and permanency of works, from less liability to the destructive effects of floods or other probable causes.

In the month of March last, when our Government thought proper to have our maps and plans, the results of close instrumental surveys on the Isthmus of Panama, and also those known as the Atrato-Napipi route, published for presentation to the Congress called to assemble at Paris on the 15th of May, it was considered desirable that I should go abroad to present them, with such other surveys as had been recently made under its orders.

I suggested that I had been one of a Commission appointed by the President on the 13th of March, 1872, for the purpose of examining into and reporting upon the question of a ship canal across the Continent, and that on the 7th of February, 1876, this commission had made its report as to locality, etc., which had been acceptable to the Government. It seemed to me, therefore, that some other person should be selected to attend the Congress. A second objection was that the selection of the canal route was eminently a question capable of settlement only by the ablest engineers, and those of the highest character. I urged further, that Commander E. P. Lull, of our Navy, who had been engaged on the surveys of Caledonia bay, and south of it, and afterwards had been chief of the parties making the surveys of the Nicaragua and the Panama routes, could well take my place, as he had a rare judgment and capacity, which would enable him to present fairly such work as he had done in comparison with the surveys made under the direction of other officers.

Notwithstanding these representations made by me, I found that the Government preferred my going as a delegate, when of course I appreciated fully the honor, and made such suggestions as seemed necessary to discharge properly the duties which belonged to the position. It seemed to me important that the civil engineer who had been employed on both the Nicaragua and Panama surveys, and who had performed his duties most satisfactorily to the officer conducting them, should go also, either as my assistant or as a delegate, to make the technical development of the routes. The suggestion was carried out, and I may add that, so far as I am aware, Civil Engineer Menocal performed his duties with entire satisfaction to our Government. In presenting important information to the Congress, the results of our Government surveys, it seemed necessary that certain ideas connected therewith should be expressed. For that reason, what I shall hereafter call my "Address" to the Congress was prepared, and submitted to the inspection of the department of our Government under whose instructions I went abroad. On arriving in Paris, the day preceding the meeting of the Congress, Mr. Menocal and myself lost no time in paying our respects to M. Ferdinand de Lesseps, too widely and too favorably known to require further comment, unless I may add that then and on all other occasions our intercourse was in all respects agreeable.

On the morning of May 15, preceding the meeting of the Congress, I received a visit from M. Blanchet, an agreeable French gentleman who had been to Nicaragua on two occasions to secure a concession for the construction of a ship-canal, and indeed had one, which last March was rejected by their Senate. I was informed by him that the previous evening M. de Lesseps had either caused a meeting to be held or an agreement entered into that was acceptable to M. Blanchet, and to the party in the Congress who would support the Panama project. My understanding of this was that they had agreed to permit the discussion of the question to stand on its merits, and that which ever side lost the vantage ground, would receive some recompense which had been agreed upon in advance. Once at least during the sitting of the Congress I received a visit from M. Blanchet, who seemed to be very much excited about the question, and to think I should be also. I told him that the decision of the Congress was no concern of mine; that my duties would be discharged by making a fair and full presentation of all the information in the possession of our Government, which was in fact the object of my being in Paris. After the adjournment of the Congress, previous to my leaving, I received another visit from M. Blanchet, who informed me, or at least conveyed the impression, that his opponents had acted in bad faith with him.

On the meeting of the Congress on May 15, an immediate organization was effected, M. de Lesseps being chosen President, with five Vice-Presidents.

The names of the members of the different Commissions were called, as follows: 1st, Statistics; 2d, Economic and Commercial; 3d, Navigation; 4th, Technical; 5th, Ways and Means.

After naming the members of the Commissions M. de Lesseps remarked in a jocular manner that our work was all cut out, that many of the delegates were anxious to get home, and that we could carry the work through *à l'Américaine,* which may be translated *with a rush.* The full meeting of the Congress was then adjourned until the 19th; the Commissions met at 9 o'clock the following morning.

Owing to the non-arrival of our heavy package of books, maps, etc., I was not able to present them the next day, as desired, but did so on the morning of the 17th to the Technical Commission. On their presentation I stated that I would have my remarks printed in French and English. The following day copies were in the hands of the Secretary for distribution to such persons as wished them. The address was as follows:

GENTLEMEN : The Government of the United States has conferred upon me the honor of presenting for the consideration of this learned and distinguished body several surveys, recently executed by its order, a part of them published only within the past month In their order from the North to the South, they are as follows :—

1. The survey of the Isthmus of Tehuantepec, by R. T. Shufeldt, now Commodore U. S. Navy.

2. The survey of what is known as the Nicaragua route, an actual location of an interoceanic ship canal, with several tentative lines, by Commander E. P. Lull, U. S. Navy, assisted by Civil Engineer A. G. Menocal, U. S. Navy.

3. The survey of what is known as the Panama route, an actual location of an interoceanic ship canal between Aspinwall and Panama, including feeder, etc.

4. The report of the surveys made by Commander T. O. Selfridge, U. S. Navy, extending from the Gulf of San Blas on the Atlantic and the Bayano or Chepo river on the Pacific coast to the mouth of the River Atrato on the Atlantic, to the Gulf of San Miguel on the Pacific coast, involving many tentative lines, and thence following up the River Atrato 150 miles, and from thence up the valley of the River Napipi, known as the Atrato-Napipi route, and terminating on the Pacific coast at Chiri-chiri.

5. An actual line of location for an interoceanic ship canal, of what is known as the Atrato-Napipi route, terminating as before at Chiri-chiri, by Lieut. Frederick Collins, U. S. Navy.

Maps, plans and calculations for material and labor on a common basis of cost are made for the "Nicaragua," "Panama," and "Atrato-Napipi" routes, as located, affording a ready means of finally considering the relative cost of executing the work on the several routes.

On the 13th of March, 1872, the President of the United States appointed a commission whose duties were "to examine and consider all surveys, plans, proposals or suggestions of routes of communication by canal or water communication between the Atlantic and Pacific oceans, across, over or near the Isthmus connecting North and South America, which have already been submitted or which may hereafter be submitted to the President of the United States during the pendency of this appointment, or which may be referred to them by the President of the United States, and to report in writing their conclusions and the result of such examination to the President of the United States, with their opinion as to the possible cost and practicability of each route or plan, and such other matter in connection therewith as they may think proper and pertinent."

A final report was made by this commission on the 7th of February, 1876, copies of which are furnished for the consideration of this Congress. It was composed of the Chief of Bureau of Engineers, U. S. Army, the Superintendent of the U. S. Coast Survey, and the Chief of Bureau of Navigation, U. S. Navy. It held its sittings at various times and considered all of the information then existing, and concluded that the various surveys and reconnoissances extending over the wide region involved were sufficient to arrive at a conclusion, except in the region lying in the vicinity of the Panama railroad; it therefore requested the Government to have a survey made and an actual line of location for an interoceanic ship canal on the best route found practicable in that region, which was done without delay. The Government, at the same time, thought it advisable to have a more thorough examination and actual location made along the entire length of what is known as the Atratro-Napipi route. After a careful study of these surveys, maps, plans and estimates, in addition to the information which was previously before it, the commission made its final report, before alluded to.

In the consideration of a great work, such as the construction of a ship canal across the American continent, we may well suppose that its permanency should be regarded as important as the selection of the route itself, involving the least cost of construction with the minimum of problems of doubtful cost in the execution of the work. With these points assured the question becomes fairly debatable, whether the physical conditions are to be considered too formidable to admit of the execution of the work, as a commercial or monetary question—in fact, whether a grand idea for the amelioration of the great commerce of the world can be put into execution, or, perforce, must be abandoned, through the existence of obstacles too formidable in their nature to admit of an endeavor to overcome them.

Should it be considered, after a careful and minute examination of the question, that a commercial or monetary success is practicable in the construction of an interoceanic ship canal, whatever error may obtain by the selection of an inferior route through a misapprehension of conditions of permanency, or of first cost of construction in the location of the ship canal, would work a double injury, in the failure to yield a proper dividend, by reason of unexpected and extraordinary cost in construction, through constant demands for heavy expenditures in the endeavor to keep the canal navigable, and in the probable imposition of tolls, which would tend to drive away or fail to secure a considerable part of the tonnage which should naturally pass through it. This would make the ship canal appear rather as an obstructor than the promoter of a world-wide commerce. I feel sure that these considerations will have weight in the mind of our distinguished President, at whose call this assemblage has met, to whose genius and indomitable energy are due the inception and the completion of the Suez Canal.

I shall leave to my able associate, Civil Engineer A. G. Menocal, U. S. Navy, a minute presentation of the surveys upon which he was engaged—namely, what are known respectively as the "Nicaragua" and the "Panama" routes. His note-books and other data will show that the plans and estimates are based upon substantial and sufficient information.

There are certain comparative conditions affecting the execution of the work on the three different lines, upon which we give maps, plans and estimates, which it is important to bear in mind in the consideration of the subject of the construction of a ship canal.

In respect to the Nicaragua route, it may be said that the rainfall is comparatively small. Our observations at Lake Nicaragua, extending over one year, show an annual rainfall of 48 inches, or 1.22 metres.* There is a distinct dry season of between five and six months, when work in progress would not be delayed or injured, and but little interruption need be apprehended in the rainy season on that portion of the canal between the lake and the Pacific, as the rains generally fall at night, with occasional showers during the day.

There is abundant good stone, hydraulic and other lime, wood and bamboo, which latter may be found very advantageous in the construction of harbors.

There is a considerable population, well disposed, and when they can have remunerative employment, fairly industrious. The country has an abundant cattle supply of good quality for food, and other productions which would furnish the main subsistence for laborers on the canal, with a convenient water transportation in general along the line of ship canal as located, and lake communication with an extensive, populated and fertile region. This water communication can be greatly increased by the construction of a six-foot canal to Lake Managua, at an inconsiderable cost, and when completed it would make the supplies of all kinds superabundant. Between Lake Nicaragua and the Pacific, near the line of the projected canal, several passable roads exist, and whatever other roads might be required over this short distance could readily be made at inconsiderable cost.

There is an inexhaustible water supply in the lake of 2,800 miles of superfice, which equalizes floods and makes the daily changes small in the discharge of the River San Juan, by which it debouches into the Caribbean sea.

It has an excellent harbor on the Pacific coast at San Juan del Sur, convenient for anchorage as Brito itself would be if improved as a harbor, inasmuch as the vessel in transit would have time to regulate her steam and be pointed fair to enter the canal at any assigned time. This reduces the necessity of a harbor at Brito to simply securing a perfectly smooth entrance to the canal.

Lake Nicaragua affords every facility for an interchange of cargoes that may be desired.

The western coast and valley of the lake are, as compared with the eastern slope, comparatively healthy, and upon the eastern slope a considerable part of the labor can be done by means of dredging machines.

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* Observations since collated, extending over 1851, by Childs, and 8 months by Lnll, 1873, give a mean 82.65 inches.

The approaches to both entrances are superior in advantages to those of either of the two other routes with which the Nicaraguan is compared.

These considerations would seem to warrant the belief that cost of construction, including material, would be far less than upon either of the two other routes compared, as will be more fully shown hereafter.

The Panama route is next to be considered.

The mean annual rainfall at Aspinwall in a series of seven years is found to be 124.25 inches, or 3.15 metres. A dry season exists, but it is limited to two or three months, lessening the effective time for labor and of comparative healthfulness of the laborers employed, the wet being the sickly season.

No building material suitable is known in that region. The ties and railroad telegraph poles on the Panama railroad are brought from Carthagena or elsewhere.

The population is inferior to Nicaragua, as, also, the country, in ability to furnish subsistence for a large number of laborers.

By means of the railroad already constructed, a canal under construction would have a convenient transportation at whatever cost might be agreed upon.

The cost of the feeder and adjuncts, and other disadvantageous features (notwithstanding the shortness of the line), as shown by maps, plans, and estimates, make a total of $94,511,360, against that of the Nicaragua route of $65,722,137 *on a common basis of cost of material and labor.* In Nicaragua the material is near at hand, and subsistence abundant, while on the Panama route, or in its region, there is no material for construction, inferior subsistence and less favorable climatic conditions for labor, as before stated.

The last proposition which remains to be examined is in favor of the Atrato-Napipi route.

Although the mean annual rainfall here is not known, there is no doubt that it is largely in excess of the rainfall at Aspinwall. There is only a nominal dry season, as at any time a precipitation of several inches is likely to occur, and actually does occur many times yearly during the so-called "dry season."

The building material supposed to be available is confined to wood. Population is so scant as to be unable to furnish either assistance or subsistence for even an inconsiderable number of laborers.

The River Atrato would furnish transportation to the mouth of the River Napipi. Along the line of the projected canal the country is alternately rough and covered with swamps, so that great labor would be necessary to construct roads to secure even wagon transportation for subsistence and material for construction.

Under such conditions the projected feeders requisite would be made at great additional cost, as well as the projected tunnel and locks. In dimensions the projected tunnel is as follows: length, 5,633 metres; height, 35.96 metres; width, 18.29 metres.

On the Atlantic slope there are twelve projected locks of 3.14 metres lift, and on the Pacific slope ten of 4.54 metres lift, the summit level being 43.59 metres above mean tide.

With the view of having a definite comparison, the estimates for material and labor, so far as they are identical, were made on a common basis with Nicaragua. The cost on this basis is given as $98,196,894; but it is quite apparent that with the lack of material convenient, and of subsistence and transportation, as well as the absence of a dry season, and above all, the impossibility of making even an approximate estimate of the cost of a tunnel under such conditions, that the actual cost of the execution of the work would be far in excess of the estimate.

The same physical conditions—the absence of a dry season, and a general lack of material for construction, except wood, and the lack of subsistence—were found to exist by all of our parties, at various times, on what is known properly as the Isthmus of Darien, and of all the region lying south of it.

The long period of time over which the surveys of the United States have been prosecuted, designing to elucidate the problem of an interoceanic ship canal, indicates a persistent interest in this subject. I am happy to add that the present chief magistrate and his cabinet are fully alive to the benefit to be derived from a full consideration of the construction of an interoceanic ship canal, now that further researches of the topography of that region no longer promise a commensurate reward.

The people of the United States will look with great interest upon the discussions and deliberations of this distinguished convocation, and to suggestions which indicate the means that may be adopted to secure a speedy commencement of the work of an American interoceanic ship canal on such a basis as should assure its uninterrupted prosecution and early completion. It would seem that this object could best be accomplished by making the work actually International, could a proper and satisfactory basis of coöperation be arrived at.

The people of the United States recognize the great amelioration and benefit that the commerce of the world would derive through the completion of this great work, and are not disposed to regard the consideration of this subject solely with reference to the degree in which the commerce and the interests of the United States will be relatively benefited through its construction, as compared with the advantages that may accrue to other commercial nations. Such a ship canal cannot fail to be a great and common benefit, especially in opening a rapid and easy transit between the Atlantic coasts of Europe and America and the western coasts of America, and by the speedy development of Australia. Regarding this interoceanic ship canal when completed as the greatest possible artificial highway that can be constructed, conferring benefits on all nations and peoples, the people of the United States consider its construction as something of common interest, and the guaranty of its neutrality a duty in common to all nations.

The presentation of maps, plans, etc., was followed by a technical exposition of the Nicaragua route by Civil Engineer Menocal. Afterwards, in answer to inquiries, he gave the methods of proposed improvement of the harbor of Greytown and the regimen of the bar, as observed by him during several recent visits to that locality. I may add here properly, that the able sub-commission subscribed to the efficiency of the proposed method, and as well to the method proposed for constructing the dams across the San Juan. Several engineers of note at that time not favorably disposed to the Nicaragua route, made many inquiries, with the view of developing its difficulties and its inferiority, and became so well informed as to adopt it as the route offering relatively the fewest difficulties, and in the end *certainty of execution.* These engineers were found afterwards among those who abstained from voting.

On the second general meeting of the Congress, May 19, Sir John Hawkshaw, of England, whose reputation as an hydraulic engineer is second to none, was present. The afternoon was taken up in a desultory discussion of the Panama route by Lieuts. Wyse and Reclus, of the French Navy. A considerable part of the discourse was directed to the Nicaragua route, *which was not then under discussion.*

The data upon which these plans were constructed was quite insufficient. The cause of the anxiety of Lieut. Wyse, when in the United States two months before, to obtain tracings of our maps and plans, became at once apparent. They were not furnished, because it was considered improper to give them publicity abroad in advance of their publication at home.

It will be remembered that previous to last autumn, after making an examination of the valleys of the streams falling into the Bay of San Miguel in 1876–7, and visiting that region the following season, Lieut. Wyse made plans and estimates for two routes, calling the one preferred by him the Tuyra-Tupisa route, which by his report was supposed equal, or nearly so, to any that had been developed through our surveys. This line seemed to me hopeless, from the existence of the gravest difficulties, some of which I mentioned in my paper of November last. It seems, from what I shall presently quote, that Lieut. Wyse had the frankness to inform the Society for which he was acting that in his view a ship canal across that region was impossible. He did not present it at all in the Congress, but took up the Panama route on whatever information he had, and developed it for a ship canal *à niveau,* which certainly was a step in the right direction. It may be said without dispute, that for a canal at the ocean level the line from Panama to Aspinwall is far preferable to any other. The *possibility* of it must be considered simply in a commercial sense, as a canal, wherever made, must have that condition. The following day, May 20, Civil Engineer Menocal was invited to explain the plans and estimates of the Panama route, but was so interrupted by questions that Sir John Hawkshaw suggested allowing him to proceed, and submitting questions afterward.

He stated that when Commander Lull and party began the survey of the Panama route there was no pre-occupation as to what height above the sea, if any, would be selected as the summit level. They found at Matachin that the floods of the river passed some five or six feet over the railroad track, and that at low water the surface of the stream was forty-two feet above the ocean level. In considering the question it became apparent that if the ocean level were adopted, an excavation would be necessary, making the normal surface of the proposed canal forty-two feet below the present low water, in the river, which would then make a small cascade, and in periods of floods would be transformed into a cataract of one hundred and sixty-one thousand cubic feet per second, of a height of nearly seventy-eight feet, the decrease being due to the measure of the velocity of the water as it approached the precipice, and also to the head of water above the ocean level after falling, which would give a corresponding velocity on its course to the sea. It was apparent that either this great volume of water must be received into the canal from an elevation which would make the effect destructive, or that it would be necessary to "lock up" so as to permit the floods to pass beneath the aqueduct, thus bringing the surface level of the water in it to an elevation of one hundred and twenty-four feet above the sea. This was found to entail the construction of a feeder, with its adjuncts, at a cost of $9,942,727, with either a doubtful or a scant water supply during a portion of the seasons of unusual drought.

On concluding, Mr. Menocal stated his willingness to answer questions, without eliciting any more.

On the 21st another general session was held. Sir John Hawkshaw gave his opinion on the Panama route as follows:

"With regard to the question whether the canal should be constructed with or without locks, the following points occur to me:

"If the canal is to be without locks its normal surface level would be that of the sea, and its bottom level, say eight meters lower.

"This being the case, the canal would receive and must provide for the whole drainage of the district it traversed.

"Therefore it would be necessary to ascertain the volume of water that would drain into the canal before it would be possible even to determine the sectional area of the canal.

"If the canal have a less surface fall than the river, as it would have, it must have a larger sectional area to discharge the same volume of water.

"The average section of the river in a flood at Mameï was ascertained by M. Reclus to be 1,310 square metres. This would require a canal, if it were eight metres deep, to be 160 metres wide.

"The waters of the Chagres would have a tendency to flow towards the Pacific, that is, through the tunnel, as the distance is less and the fall greater than to the Atlantic.

"It seems to me that the dimensions of the tunnel, if it has to serve for both the river and canal, would be too small. Mr. Menocal's estimate of the volume of the Chagres in time of flood would much more than fill the tunnel; and in any case the whole section of the tunnel is only half that of the river in time of flood, as given by M. Reclus.

"During the construction of a canal at the sea level, difficulties would arise in providing for the drainage, which would affect both time of execution and cost to an extent that could hardly be ascertained in advance.

"If, from such considerations as the foregoing, it should be concluded that the canal should be so constructed as to retain the rivers for natural drainage, then recourse will have to be had to locks. In that event there can be no difficulty, in my opinion, in carrying on the traffic with locks properly constructed, provided there is an ample water supply, which would be a *sine qua non.*"

It will be observed that Sir John Hawkshaw expressed the axioms heretofore acknowledged by able engineers : to avoid surface drainage, and to have an abundant water supply. After reading his opinion, he remarked that a residence of two or more years in Intertropical America had given him a knowledge of how these showers behave; without which he might think differently. In a conversation with him before he left Paris, after two days' attendance at the Congress, he expressed to me the opinion that the canal could not be excavated *à niveau*, and if it were that it would be filled up with trees and silt.

A pamphlet by M. Dauzats, Chief Engineer of the Suez canal, compares that work with the various routes proposed across this continent. He quotes at length from my last paper read before this Society showing the marked contrast of physical conditions, the region of the Suez canal having a mean annual rainfall of less than two inches, whilst the region of the Panama canal has a rainfall of one hundred and twenty-four inches. His deduction is that surface drainage falling into a canal, has a scouring effect which is beneficial, whilst the abrasion of the banks of a canal is far more destructive.

Were it not too great a tax on your patience, I would point out the fallacy of such an argument. It is assumed that when a river like the Chagres is dredged, it will change its regimen. This deduction is necessary to a supposition that a canal *à niveau* at Panama is possible.

On the afternoon of the 19th, the Technical Commission was divided, one part to report upon the practicability of locks as presented on the Nicaragua route, the other to consider the question of making tunnels for navigation. There was confusion and violent action, I was informed, on the part of Lieut. Wyse, growing out of his opposition to Mr. Menocal being put on the sub-commission on locks. Mr. Menocal very properly asked to be excused.

The report as to locks was, that they could be made to serve their purpose. The calculations for a tunnel were made for construction on a dry foundation ; it was stated there were no elements of calculation for building a tunnel below the sea level, as the plans demanded.

During the sittings of the Congress, I found myself frequently obliged to dissent from the propositions of Commander Selfridge, U. S. Navy, who strangely enough was found in the Congress without being named by our Government. This officer had been the chief of large parties who were engaged during the seasons of 1870, 1871 and 1873, in examining the coast lying south and east of the Panama route, at San Blas, Caledonia bay, the streams flowing from the flanks of the mountains adjacent to the Bay of San Miguel and of the counter slopes falling into the Atlantic ; also in making an examination of the Atrato-Napipi route for a ship canal, which will be found in his report to the Secretary of the Navy, June 12, 1873.

I refer the curious reader to pages 66 to 70 inclusive and to map VIII, illustrative of the Atrato-Napipi route as developed by Commander Selfridge. Nobody reading this report and referring to the drawings would suppose for an instant that the greater part of it was purely imaginary, the ground lying between the rivers Atratro and Doguado never having been passed over by Commander Selfridge or any of his party. It is delineated as an inclined plane, locks located and sections of elevations given in figures ! Between this fanciful presentation and the profiles made by Lieut. Collins, U. S. Navy, there is a very wide difference. I quote from page 7 of my report :

"Commander Selfridge then said that the remarks made by Sir John Hawkshaw in relation to the Chagres River were not applicable to the Atrato-Napipi route, and endeavored to enter into a further discussion of its merits. I stated that I would suggest the advantage of discussing the carefully prepared plans of Lieut. Collins along the lines of actual location, which were the best that could be found in months of labor, instead of lines drawn at will by Commander Selfridge, involving uncertainty of execution and an entire absence of elements of calculation, as every engineer wonld recognize."

This was one of several occasions that I had to suggest the advantage of discussing facts instead of indulging in fancies calculated to deceive the credulous and unwary, and absolutely a waste of time.

The proceedings of the general Congress on the 23rd, and in the Technical Commission on the 26th, are so significant that I shall append them without omissions.

By reference to the Appendix it will be seen that the partial quotations which I shall use do not present a perverted meaning. I will submit the question to every reader of the Appendix, whether, free from any comment, it is not patent that the Congress was not called to decide upon the best routes for an interoceanic ship canal, but only upon what was *possible* via Panama.

M. de Lesseps announced : " That which struck us most, is the enthusiasm of the United States of America in favor of the establishment of a canal at Panama."

We may ask with surprise, when and where was this enthusiasm manifested ? I saw nothing of it, nor was it conveyed by the Government of the United States, in sending me to present the plan for Panama, and to submit the other surveys and reports made under its orders. I again quote M. de Lesseps: " Lieut. Wyse and his companions have rendered us an account of the mission that they undertook. Seven of them set out; four are dead in those wilds, where one is only able to effect a passage with a hatchet in the hand."

" They have then returned, and have had the honesty to declare to us that in their view a canal was impossible in the regions that they had returned from exploring." This seems sufficient to dispose of the historical sketch of M. Hertz, given on page 10 of the proceedings, as follows : " The French Committee of Study for the Interoceanic Canal [in consequence of the completion of the surveys alluded to by M. de Lesseps,] thus found itself able to submit to an Interoceanic Canal Congress a collection [of information] upon which it would be able to pronounce intelligently. It is known with what alacrity the most learned men from all countries have responded to the call." To show the sufficiency of our information previous to these surveys of Lieut. Wyse, was the object of my paper, read Oct. 1876, in reply to a pamphlet of M. Drouillet, who came to this country to obtain assistance in making further surveys. The closing paragraph of my paper was as follows : " I may add as a personal conviction, that however long and seriously the search may be continued for ' results ' by surveys, nothing can or will be developed so advantageous as that which the surveys of our Government present for your consideration." Lieut. Wyse's survey undoubtedly destroyed preoccupations in Paris, and so far was useful to them ; which they might have effected at less cost by a more thorough examination of the work that had been done by our Government.

Notwithstanding what M. de Lesseps said respecting the assertions of Lieut. Wyse as to the impossibility of a canal in that region, we find in Lieut. Wyse's last report a tabulated statement of routes, among which is the Tuyra-Tupisa, at an estimated cost of 600,000,000 francs. I quote again M. de Lesseps: " I have consulted M. La Valley, and he has replied that it (would be) decided for a canal *à niveau*,—that it was a public sentiment. I will permit myself to sustain that opinion." Again: " M. La Valley has studied the question of a tunnel; he believes it certainly possible." He says, " it is only a question of cost."

This Society will be surprised to find, on reading all that M. de Lesseps has justly said of the high qualities of M. La Valley, as given in the Appendix, that when the resolution was voted on, he, as also some other distinguished engineers of the French Society, were designedly absent. To the fact that these eminent engineers have not given the sanction of their names to what, by others, was regarded as *possible* in engineering, is probably due the discredit shown to the decision of the Congress.

I quote again M. de Lesseps : " In my belief we should not make a canal with locks at Panama, but a canal *à niveau;* that is, I believe, the opinion of the public, of which I am the organ at this moment."

Here we see that, instead of studying the question as an engineer, and in its economic conditions relatively with other routes, M. de Lesseps pronounces himself to be the organ of what he believes to be public opinion. Happily for the public, its supposed demand could not swerve M. La Valley and others of great reputation.

I call attention to the remarks of M. Peralta, as given in the Appendix. This learned and able Minister of Costa Rica to our Government is well known to many of you personally. His suggestions were not to be considered. M. de Lesseps wished nothing more embodied in the resolution than whether a canal *à niveau* via Panama was possible.

The resolution was passed as he desired by such a vote as to call forth an expression of his satisfaction—this, too, supported by the demands of public opinion, as he stated—and yet he is not happy.

I again quote M. de Lesseps: "Since 40 years I have studied the question of the Suez Canal. I have always understood that, for a profit, it is necessary to receive at the least 10 francs per ton. One can perfectly well make the American canal pay double that amount whatever project may be brought about. These are considerations that one is very glad to know for the future."

The humanitarian idea so nicely held out, and especially supported by M. Simonin, is dropped. There remains alone the idea of constructing a canal without reference to whether it is on the best location, but certainly on the line where the concessionists are entitled to receive, by the terms of the concession, 10 per cent. of the stock issued.

The Report of the Commission on Statistics of the Congress gives the tonnage likely to pass through the canal, as follows:

That of the United States	2,000,000	tons.
That of Great Britain	1,050,000	"
That of France	356,000	"
That of all other Powers	356,000	"

In the Bulletin du Canal Inter-Océanique of October 1, published in Paris, in the building of the Suez Canal, there is an article of some length, entitled "Via Nicaragua," in which is set forth in varied terms the egotism of the American Commission on the interoceanic canal Question, as shown in their Report to our Government, and also the same quality shown by our official delegates to the Paris Congress.

If this 'egotism' was shown, as is supposed, in the report, it was simply in the endeavor to promote the public interests in the most economic manner. The narrowness of the views of the Commission is supposed to be shown in recommending lockage for vessels of only four hundred feet in length, and a beam much greater proportionately than that given vessels at this time. Without having the time or patience to look up the French steamers, I will venture the opinion that all of them longer than four hundred feet could be counted on the fingers of one hand.

The 'egotism' of Mr. Menocal and myself at the Paris Congress, so far as I am capable of judging, was confined to a fair presentation of all of the information in the possession of our Government, feeling no very lively interest in what the Congress would *decide*, not *determine*, which belongs to nature, and to the keen appreciation of moneyed interests as to what will and what will not pay, After the adjournment of the Congress an engineer very much in the confidence of M. de Lesseps said to me, "Now that the matter was settled, what amount of money might be counted on in America to promote the enterprise?" I replied that, in my opinion, they would not get a dollar. Evidently, in my 'egotism,' I was wrong—to what extent will only be known when the Bulletin devoted to the canal interests publishes the amounts subscribed in France and elsewhere for the construction of the canal *à niveau*. Without assuming to speak for the public, I feel sure that such a statement would be read with interest.

Looking at the table just given of the tonnage of the different nations, we see the 'egotisms' (interests?) of all of them in form and substance. In the matter of the canal, the interests of the United States now are practically double those of Great Britain, and will become relatively greater, proportionate to the increase of population. Those of France are, roughly, one-third of Great Britain, and yet, if the word *egotism* is a proper substitution for the word interests, she has as much as all the rest of mankind.

In an interview given in the New York *World* of Oct. 9, M. de Lesseps is reported to have said: "If I may say so, I do not think the Americans are very clear-sighted in this matter. They are of the Anglo-Saxon race, and it is, to some extent, a question of race. The Anglo-Saxon race is unequaled for its power of dealing with the circumstances immediately before it, but I do not think it sees very far in the future. The Latin race has a somewhat wider intellectual horizon."

He regards the Anglo-Saxon race as eminently practical, and without being of it, I can well believe him. Granting his foreseeing power, may we not ask the probable number of Anglo-Saxons on this continent at the end of this century, and at that time, also, of those inhabiting Australia and the Pacific islands? Awaiting this reply, may we not without egotism assume it to be roughly one hundred millions of people? We can leave to M. de Lesseps, with his long view, the contemplation of the end of the next century, the period A. D. 2000. Still, even to our obscured vision, there seems a mighty multitude of men; shall we give it shape in supposing it to number at the least 300,000,000?

Dropping the consideration of humanitarian ideas so unhappily dispelled, and looking at it as a plain business matter, could we not submit the question to the citizens of the two powers first named, whether it would not be worth while to consider the construction of a canal on a *commercial basis*, and with reference to a careful examination of all of the points involved; and if found practicable in that view, do the work, and if otherwise, develop through the United States and the Canadas such additional railroads as would ameliorate the commerce of which they are so largely the factors?

After considering the proceedings of the 23rd in the general session and a part of the proceedings of the Technical Commission of the May 26, as given in the Appendix, we can proceed to consider the vote more intelligently. A resolution was introduced to conform to the wishes, as expressed, of M. de Lesseps. It is as follows:

"The Congress considers that the piercing of an Interoceanic Canal at a constant level, so desirable in the interests of commerce and navigation, is possible, and that a maritime canal, to respond to an indispensable facility of access and utilization which a work of this kind should offer, should be located between the Gulf of Limon and the Bay of Panama."

The official vote, as given in the proceedings, is as follows: Absentions, 12; against the resolution, 8; in favor of it, 78. The most significant figure is omitted. As counted up on the record, 36 were *absent*, among whom were a considerable number of engineers of note, and perhaps half a dozen delegates who were not in attendance during the session.

Had it not been that the expression of my absence from voting was regarded as an "enigma" which has been *solved* in the Bulletin of October 1, I would not have alluded to it. I abstained from voting, on the ground that "only able engineers can form an opinion, after careful study, of what is actually possible, and what is relatively economical, in the construction of a ship canal." I feel sure that it will excite a smile among us to suppose this in any degree enigmatical, and may recall the ideas so ludicrously shown in the comedy of the Irish Ambassador.

In relation to the vote and to the delegates, a pamphlet published in Paris, titled "Panama, 400,000,000 à l'eau," gives the following:

"Let it be remarked that one-half of the members of the Congress were French; they had been chosen by the organizers of that assembly; 34 members belonged to the Geographical or the Society of Commercial Geography of Paris. What was their competency to decide between a canal with locks or on a sea level? Fourteen other members were engineers or assistants of some sort on the Suez canal. What was their impartiality to decide between M. de Lesseps and others? And, among the others, if one takes count of personal friendships, and of the prestige exercised by a great name, how many more will remain?"

No one will deny that among the French delegates to the Congress were men eminent in every branch of engineering science, and others of the highest character as men of science; the same may properly be said of the foreign delegates; they were men of character and special attainments, usually having relation to the subjects that would concern a canal, if not its construction.

As regards the engineers of Holland and Belgium especially, where the land is so flat and the rainfall so small, their practical experience of a head of water would be confined almost to tidal action. However able they may be, they had not, so far as I know, the practical experience of Intertropical America that made Sir John Hawkshaw so competent an authority.

Engineers in other branches would naturally adopt the opinions of the hydraulic engineers, and, so far as their consciences would permit, be disposed to support the opinions and wishes of M. de

Lesseps, especially if expressed emphatically, as found in the Appendix. They would say very properly, the *execution* of the work was for M. de Lesseps, and not at all their affair. He had asked them to say that the canal *à niveau* was possible, and they had obligingly done so. He did not think it worth while to ask his honorable *confreres* if they thought Panama the best canal route; indeed, it would not have been prudent to do so, as he had determined that the canal should be built at Panama, *à niveau;* as expressed by an engineer very much in his confidence, "If they found it possible, the first thing was to get the money; the next was to build the canal in the best manner that they found possible." Even a great general needs the "sinews of war;" the public who made the demand through M. de Lesseps to have a canal *à niveau* should not desert him so cruelly; he has met them fully half way in reducing the cost of construction one-half as given by the Congress, and in still further shortening the time for the construction of the work as given in his provincial tours, beyond that assigned by him in the Commission on the 26th, as shown in the Appendix.

I do not propose to discuss the terms of the concession fully, as found on page 281 of the report of Lieut. Wyse. I will point out some features that seem to me objectionable in the extreme.

The Canal Company agrees to transport, gratuitously, all persons in the civil and military service of Colombia, their baggage, arms and ammunition, and if the company is not provided with vessels suitable for their transportation, to pay their passages, and for the transportation of armaments and ammunition.

The Government of Colombia is to receive semi-annually five per cent. of the gross receipts of the company for the first 25 years, six per cent. for the second 25 years, seven per cent. for the third 25 years, and for the remaining 24 years eight per cent., at the end of which time the canal reverts to the Colombian Government.

The Company is "authorized to reserve ten per cent. of the shares for the benefit of the founders and aiders of the enterprise."

The only hope for a stockholder would seem to be in the extraordinary impost of ten francs per cubic metre, not on the gross tonnage or weight of the vessel and cargo, but upon the cubical contents of a parallelopiped represented by the length, breadth and draught of the vessel! Lieut. Wyse supposed that this measurement might amount to 30 francs per ton, which, if imposed on ordinary cargoes at ordinary prices, as wheat, would make a voyage from San Francisco around Cape Horn preferable in economy.

Looking at the terms of the "concession," as it is called, and the whole matter from beginning to end, the wonder is that the subscriptions were so large, rather than that they were so insufficient for the purpose of constructing a canal.

When Lieut. Wyse was before a Commission in the Congress he was questioned as to the Panama Railroad and its franchises, and replied that he had made a satisfactory arrangement, by which the Canal Company would gain two millions of francs yearly, but gave no further explanation as to the arrangement.

So far, in general, we have been regarding the aspects of the interoceanic canal question from other points of view than our own, with occasional objections or remarks thereon. Let us now look at the question from our point of view.

After the adjournment of the Congress it seemed to me that its high authority, and that of M. de Lesseps, who does not in the interview overstate the confidence with which he has been regarded in France, would deprive many peasants of their hard earnings; what kind angel protected them Heaven only knows. So far as the English and our countrymen were concerned, the decision of the Congress did not seem to me likely to inflict injury, other than a delay and an uncertainty as to the time of commencement of a great work.

In my report to the Secretary of State, which many of you have doubtless read, I made the following deductions relating to the Congress:

That personal interests, arising from a concession for the construction of a canal, are unfavorable to a relative consideration of natural advantages as between two or more routes; that such personal interests did exist was quite apparent from first to last; and the "concession" was frequently partially discussed or alluded to, especially in the committees or sub-committees.

That the discussion in Paris has shown that hereafter in the examination of the question only the Nicaragua and Panama routes need critical examination, and that sufficient information exists as to all other routes.

That the canal *à niveau* by the Isthmus of Panama, either with or without a tunnel, has been shown to be hopelessly impracticable, if considered as a commercial question.

That a general and special knowledge now exists among European engineers relative to the subject of a ship canal across the American continent, which did not exist prior to the assemblage of the Congress in Paris.

In view of actualities, it seems proper that the Government of the United States should consider the question of the interoceanic ship canal as still undetermined, notwithstanding the report of its commission on the subject; which has received acceptance by the people of the United States, and by our able civil engineers, inasmuch as it has not received a criticism.

Should this be regarded as advisable it would seem necessary to form a commission of the ablest engineers of our army, and to invite the ablest civil engineers of our country, and as well invite all the governments who were represented at the congress in Paris to send their engineers, all to join in full discussion, and having equal powers, with the view of removing it from all extraneous influence of "concessions," or other objects than the consideration of the construction of a ship canal across this continent, capable of fulfilling the demands of the world's commerce, under the most economic conditions.

I have learned that the suggestion as to a commission was maturely considered by our Government, and was regarded as unnecessary, in view of a supposed unanimity of the people of the United States in favor of the Nicaragua route.

It seems to me, however, that this fact, which I think undoubted, does not do away with the great advantage of the discussion of the subject by the ablest engineers; especially if, after a close study of the Nicaragua and Panama routes as presented by the surveys, they should visit both localities for the purpose of verifying any part of the work desired, and of the existence or non-existence of material for construction, and the methods which could best be employed in the execution of the work. This done, so far as human action can go, the question will be presented with the least possible condition of error—the locality where the canal should be made, or whether a canal should be made at all.

When it seemed to me that our Government was not disposed to call a commission, I wrote, at the suggestion of a gentleman of position and influence, to Sir John Hawkshaw, presenting the advantage that the subject would derive from a personal inspection of the Nicaragua and Panama routes, either by him or some able engineer appointed by the Society of Civil Engineers of Great Britain, accompanied by another appointed by the Society of Civil Engineers of France, and also another by our own Society, or, if our Government thought proper to detail Gen. Weitzel, U. S. Engineers, or any other competent officer who has had large experience in hydraulic works. As yet I have received no reply.

The public is aware of the willingness of General Grant to assist in this great work, under such conditions of organization of a company and of a concession as would enable it to be prosecuted vigorously and effectively. He has given the subject his careful attention for years; is well satisfied as to the route, which possesses a certainty of realization by development; he appreciates fully the great importance of the construction of the ship canal for the commerce of the world, and especially for the full development of our West Coast.

It is gratifying to observe that there is an universal expression of opinion as to the advantage which the construction of the canal would derive from having General Grant at its head. The expression is unanimous that it would ensure an economical, intelligent, and vigorous prosecution of the work, and its completion within the shortest time, and that it would have all of the conditions of practical utility and permanency that could be secured.

Recent information, from the most reliable sources, gives the assurance that the intelligent people and Government of Nicaragua are in entire accord with this movement, and instead of embarrassing the question with impossible conditions, will do all in their power to forward the great work.

To sum up the whole matter, we may well desire that our countrymen should know what canal route will best serve the commerce of the world, in which our countrymen are so largely interested. This is eminently a question for the ablest engineers to pronounce upon. Exact information will be presented in a prepared form by Civil Engineer Menocal, U. S. Navy, for discussion by the Society of Civil Engineers of the United States, showing the quantity of work that will be found necessary on the Panama route at the ocean level, and also by way of Lake Nicaragua, with a lockage of 107 feet above the ocean. It is really not a question of what we may desire, but actually only of what Nature, whose forces are ceaseless and tireless, will permit. To enter into an ill-advised struggle with them is to be defeated in the end, at whatever cost or continued effort. The labor and expense of constructing a ship canal, under the most favorable conditions granted by Nature, will be great, but the result attained will be the grandest that man is capable of achieving for the convenience and extension of the commerce of the world.

Through this discussion we may hope that all of the advantages as well as the difficulties, positive and relative, on those routes, will be fairly developed—not upon fanciful presentations, but upon sufficient information through calculations.

I have taxed your patience in an endeavor to show the present aspect of the ship canal question, and have now only to point to the importance of the forthcoming calculations in detail, and the irrefragable results obtainable from their full and fair discussion.

Gen. Egbert L. Viele, of the Council, then read the following letters:

Letter from Frederick M. Kelley.

[Before reading the letter of Mr. Frederick M. Kelley, Gen. Viele said: Mr. Kelley has spent 27 years' time and over $120,000 in cash in promoting the success of a ship canal without locks through the American Isthmus, and during that time has sent to the Isthmus seven different surveying parties and procured two governmental expeditions to examine all the feasible routes via the Atrato and San Juan valleys during the years 1852, '53, '54 and '55. The reports of the engineers, Messrs. Troutwine, Lave, Porter, Kennish, McDougall, Sweet and General Michler, who had charge of those surveys, can be seen in the public libraries.]

No. 153 West 45th Street,
New York, December 7, 1879.

My Dear Sir: Your favor of Nov. 26, inviting me to be present at the meeting of your Society on the 9th to hear Admiral Ammen's Nicaragua Ship Canal paper read, I received in due time, with thanks; but on account of serious illness in my family I will not be able to attend.

I would be very glad to see the Admiral, as it was my good pleasure to make his acquaintance some years since in Washington; notwithstanding I have no confidence in the enterprise of which he is so zealous and able an advocate.

Twenty-seven years' study of the question, and an extensive intercourse with men engaged in shipping interests in this country and Europe, have convinced me that a *short sea level canal*, with good, safe harbors, which will require no dredging or other improvements to keep open, and which can be reached safely at all times on a wide, open sea, is what the commerce of the world demands, and will have sooner or later, cost what it may.

These important and necessary conditions the Nicaragua route does not afford, as it is 180 miles long, requires 18 or 20 locks, so liable to get out of order in the wet, decaying Isthmus climate, and has no good natural harbors on either ocean.

A canal via the San Blas route will give us a deep, wide cut through the narrowest part of the isthmus, through which vessels may pass from ocean to ocean quickly and cheaply on an even keel, without the expense, dangers and delays of locks, save one tidal lock to control the high tides of the Pacific.

A ship, at the rate of three miles per hour, could be towed through the San Blas canal in 10 hours, and thus 100 going from the Atlantic to the Pacific, and 100 from the Pacific to the Atlantic, 200 ships could pass the Isthmus at this narrow point in 24 hours with perfect ease. The same ship going at the same speed would require 70 hours to pass the Nicaragua canal, including delays at its numerous locks, even one of which, if disabled, would detain the ship no one can tell how long—perhaps weeks or months. It would be a great misfortune to build a long, many-locked canal like the Nicaragua, as that would result in constructing another one at the narrowest part of the Isthmus.

The San Blas route surveyed by Messrs. McDougall, Sweet, Foreman, Rude, and Fountain in 1864, and *partially* examined by Commander Selfridge in 1871, is but about 30 miles long, of which 10 miles is the Bayano river, easily, for a trifling expense, made navigable for ships, thus leaving only 20 miles for canalization. Of this, however, 7 miles is a tunnel, which the engineering skill of this day, with steam and compressed air drills now in use, can drive, without serious difficulty, the same as they have the Hoosac, Mont Cenis, St. Gothard, and other tunnels in this country and Europe, which, 25 years ago, with the old mode of hand-drilling, would have been thought impracticable.

In attempting to solve so great a problem as the best and only route for a ship canal, it is important that additional surveys should be made, especially of the San Blas route, which is much the shortest of all proposed, as by this means a lower and shorter pass will doubtless be found by flanking the sugar-loaf shaped hills which extend through that part of the Isthmus.

The party should be in charge of a competent army officer like General N. Michler, who, in 1858, by order of Congress, made the very creditable and able survey of the Atrato Truando route for a canal without locks, via the Atrato Valley.

As we are building the canal for all time, and to satisfy the ever expanding wants of commerce, it is the height of folly to locate it where dangerous floods and almost bottomless swamps will destroy it, and thus render useless the undertaking which has cost millions of money.

The safest and most reliable material to excavate in that country is rock, and the *more miles of rock* the canal passes through the more safe and durable will be the structure, the less walling will be required to keep the banks from falling in, and the less will be the cost of maintenance after the work is finished.

Of about 30,000,000 of cubic yards of materials to be removed on the San Blas route (which is much less than on any other route excepting the Atrato-Napipi), about 25,000,000 is rock, and hence the canal located there would be more safe and solid, and cost very much less to maintain it in the future.

This, in the long run of years, is of very great importance to the stockholders, as every railroad man in the country fully comprehends. If it costs all the receipts to maintain the work, where will the shareholders get their anticipated dividends? I have had careful estimates made by the engineers employed, and the total estimate of the cost of the canal is $104,000,000. The estimate of cost of the tunnel, 80 feet wide at the water line, and 120 feet high from the bottom of the canal, is $54,000,000.

Yours, very truly,

FREDERICK M. KELLEY.

CHIEF JUSTICE DALY,
President of the American Geographical Society.

Letter from Nathan Appleton.

NO. 10 COMMONWEALTH AVE., BOSTON,
December 3, 1879.

CHIEF JUSTICE DALY,
President of the American Geographical Society.

DEAR SIR: I beg to acknowledge, with thanks, the receipt of your letter informing me that Admiral Ammen is to read a paper before the Society, at New York on December 9, on the Nicaragua canal question, and inviting me to take part in the discussion that will follow it.

It will be impossible for me to be there, as I have an engagement at Washington on the following day, to attend the quarterly meeting of the United States Board of Trade.

All I could say would be to vindicate the earnest efforts and the honest intention of the International Congress held at Paris last May, under the presidency of M. Ferdinand de Lesseps, to decide upon the best route for a canal across the American Isthmus.

I certainly believe that its decision in favor of a tide level canal by Panama was the right one. I think that, if the same Congress should meet again and discuss the question for a month instead of a fortnight, it would come to exactly the same conclusions. Moreover, I believe that if an American Congress should be convened at New York, it would arrive at this result, which is, that the only canal which can respond to the demands of commerce is a straight cut from ocean to ocean, without locks, and without a tunnel; and for this the only place thus far known, on the long stretch of the American Isthmus from Tehauntepec to Napipi, is at Panama.

The line which was selected by American engineers for a railroad, thirty years ago, stands unchallenged to-day as the best place for that other road of travel and communication—a canal.

I see no difficulty in building a canal by Nicaragua, nor would its expense be very great; but I contend that when it is done, with its seventeen locks, more or less—a great ascending and descending water staircase, to utilize the reservoir of the Lake of Nicaragua—it will be a mere curiosity of engineering, but of no practical use, for it will not enable a sufficient number of ships to pass through it per day to encourage them to make the attempt.

I am not willing to accept this as the "American plan"; for I say it is paying a very poor compliment to the intelligence of our people to suppose that they will endorse any but the best project for a ship canal.

The engineers who have been examining the line by Panama since the decision of the Paris Congress declare that the difficulties in the way of a canal there are less even than they had imagined.

When M. de Lesseps shall have gone there and looked at the ground himself, as he proposes to do very shortly, if he, too, states that a tide level canal is possible at Panama, as he has proved it to be at Suez, then I suppose the world will accept his decision.

We can congratulate ourselves upon the interest General Grant takes in the canal question; and you can judge how much M. de Lesseps counted upon his co-operation, for he offered him the first honorary presidency of his company—the only possible position he could offer in a company which had no legal existence—as the most conspicuous citizen of our land.

If these two great men will work together to build a canal in the right way and in the right place, there is little doubt but that it will soon be finished.

The canal opened through the American Isthmus must be the highway of the world, secured by absolute neutrality. There should be no national jealousy as to which nation will take the initiative in building it; but how can it better be done than by the joint action of the people of the two great republics on either side of the Atlantic ocean—France and the United States?

As I cannot attend your meeting, I desire to present the following resolution by letter:

"*Resolved*, That the American Geographical Society takes proper steps to give M. Ferdinand de Lesseps a fitting reception on his arrival at New York, and that he be invited to deliver an address on the subject of the Interoceanic Canal."

Asking you to read this letter, if possible, at the meeting, I have the honor to be

Very truly yours,
NATHAN APPLETON.

Letter from Walton W. Evans, C. E.

The following letter from Mr. W. W. Evans, member of the Council, was preceded by one to the President of the Society, in which Mr. Evans expressed his conviction that the San Blas route was preferable to the Nicaragua and Panama routes, in which he states that he agrees with M. de Lesseps that the canal to be built should be a tide water, or sea level canal; and that, to be safe, reliable, and at all times ready for quick transit, it must not be on a line of drainage, in such a country as the Isthmus—a region where, for more than half the year, the heavens pour down floods of water. He told M. de Lesseps, in Paris, that he never could build the canal on the Panama route, as proposed by the Congress, and says that when M. de Lesseps reaches there he will find the physical conditions very different from those on the Isthmus of Suez, where he had a rainless region, and was required simply to dig in the sand, with no obstructions in vegetation, or rivers to contend with. In our Isthmus, on the contrary, there must be encountered continuous floods of rain, rock covering nearly the whole distance, and vegetation so dense that one can scarcely see into it, with which are united pestiferous influences from insect life and other causes Mr. Evans calls attention to the fact that earthquakes occur nearly every day there, and says he thinks that this earthquake element has not been duly considered by Admiral Ammen and others, who advocate a canal with locks. He has seen houses so twisted by earthquakes that no one could open or shut a door in them; and what, Mr. Evans asks, would be the efficiency of a canal, if the locks became so warped that no power could open or shut the huge gates that would be required?

Mr. Evans says further in this letter, that he has had seven years' experience in canal building; that he has crossed the Isthmus at Panama many times, and lived in earthquake countries; that he has studied the subject of a canal across the Isthmus for more than thirty years; and flatters himself that he knows as much of what is required as most of the gentlemen who are now discussing the question.

Having been requested by the President, in consequence of this letter, to attend the meeting of the Society at which Admiral Ammen's paper was to be read, Mr. Evans being prevented from doing so by illness, sent the following letter. Before reading the letter, Gen. Viele said that, being himself an engineer, he deemed it proper to say that Mr. Evans was considered by the profession one of the ablest engineers of the country.

SANS SOUCI, NEW ROCHELLE, N. Y.,
December 5, 1879.

Chief Justice DALY,
President of the American Geographical Society.

My Dear Judge: I received your kind note of Nov. 23. I am still troubled with a terrible catarrh in my throat, and when I venture out I have added asthma, and then can hardly move. As long as I remain in the house, I am pretty well. I will try to write my opinion in reference to the Interoceanic canal, so it can be read when the matter is discussed before the Society. I was invited by M. Lesseps to be a deputy at the Paris Congress. I was in Berlin, but excused myself from going by saying that I could not hear anything, so I could not join in the discussion, but I would write a paper, or rather a letter, to my brother-in-law, M. C. A. von Hernert, who lives in Paris, and was a delegate to that Congress. I wrote it hurriedly and sent it. I never knew if it was read or not. I sent a copy of it to Mr. Evarts, but I do not know if he read it or not. I will look up this letter and send it to you to read. I consider this canal the most important matter in the line of progress that is now before the world; it is of vast importance to England, but it is of still greater importance to the United States. England cannot much longer keep her eyes shut to the injury the Suez canal is doing towards destroying her grip on the trade of the world, and I fully believe in the truth of the remark made by Michel Charlier, that the Suez canal was an artery that if kept open would bleed England to death. Her only power to counteract this influence is to join us, and cut the Isthmus canal. I see by the papers that the influence of Admiral Ammen, backed by Gen. Humphreys and Carlilo Patterson, will be so great that it is a matter of difficulty to counteract it, but I would like to have my opinion in the matter put on record in our Society; it can be summed up in a few words; it is this—that a canal built on the Nicaragua route will be when finished a total failure, and all the money invested in it utterly sunk, for the day is not far distant when the trade of the world will demand that a canal be built between the two oceans on the shortest route, and on the most direct line, regardless of the difficulties that may be encountered. This route is the "San Blas route." It is acknowledged to be the route by Totten, Troutwine, and Sweet, all old canal engineers, who have lived on the Isthmus and know it well, and this is also the opinion of Mr. Kelley, who has spent a fortune in surveys to find a proper route for this very canal. I hope in a few days to be able to put this matter in better shape for you to read to the Society, but I wish here to say that if we now turn our backs on the San Blas route in fright, merely because it calls for a big tunnel to be cut, and because it may possibly cost in first outlay a little more than the Nicaragua canal, we will in a few years be ashamed of ourselves, and confess that we had not a quarter of the pluck the Spaniards had two hundred years ago, when they cut the "Desaguadero" in Mexico, a work that called for the excavation of three and a half times as many cubic yards of rock as would be required to cut a ship tunnel ten miles long, 160 feet high, and 80 feet wide. Our weak-kneed people, who get frightened at the idea of a tunnel, should go to Europe and study tunnelling as done there. I found over 200 tunnels between Nice and Spezzia, on the edge of the Mediterranean, cut and used for a very limited railway travel.

The line of the St. Gothard railway is a perfect marvel for tunnels. Nearly one-fourth of the whole line is in tunnels. The great or Summit tunnel is 9½ miles long; and in seven places on the line—three on the Swiss side of the St. Gothard and four on the Italian side—they have tunneled into the sides of the mountain in great entire circles of 1,000 metres diameter merely to get distance and keep the line to their fixed maximum gradient of 1 in 40, or say 132 feet to the mile. And what is all this terrible expenditure for? Why, merely to rehabilitate the trade which the Suez canal has opened for them, and which the people of the Mediterranean enjoyed, and out of which they built their great cities and filled them with wealth up to the time when Vasco de Gama discovered, four hundred years ago, the route to the East by the Cape of Good Hope. England made this route her own, and out of it she made herself the mistress of the seas, the storehouse of Europe, and the richest country in the world. The time has come for a new deal: the centres of trade are seeking new homes; the gold and silver of the western slope and the cereals of the eastern slope of America are becoming elements in the great problem of moving and fixing the money granary of the world. Bishop Berkley was prophetic when he claimed that the course of empire traveled towards us; and so was the English poet Webb when he wrote, fifty years before our Revolution, the lines—

"Rome laments her ancient fame declined,
And Philadelphia becomes the Athens of mankind."

I beg pardon for letting my pen run at random over five sheets. I commenced at first merely to say that I could not come to the meeting of the Society's Council to-morrow, as I dare not trust my throat in the cold.

Yours ever sincerely,
W. W. EVANS.

At the conclusion of this reading the President of the Society, CHIEF-JUSTICE DALY, said :

It has been said, as I am informed by M. de Lesseps, that the late Emperor Napoleon was in favor of the Panama route. I received a letter this afternoon from our Fellow, Mr. Samuel B. Ruggles, who, as the Society knows, has paid great attention to the subject of canals, which letter was accompanied by an extract from an address delivered by Mr. Ruggles some time ago, in which it is shown that the late Emperor was in favor of the Nicaragua, but not of the Panama route, in proof of which Mr. Ruggles quotes in his address several passages from a pamphlet published by Louis Napoleon, to which Mr. Ruggles requests me to call attention this evening. There is not time at present to read all that Mr. Ruggles has submitted, but it will be printed with the proceedings of the meeting. We have invited several gentlemen to be present this evening who have made the subject of this interoceanic canal an especial study. We have with us Mr. Menocal, who was a delegate to the Paris Congress ; Mr. Bogart, the Secretary of the Society of Civil Engineers ; Mr. Gardner, the head of our State Survey ; Signor de Franco, of Nicaragua, and Mr. Frank de Y. Carpenter. I do not know that any of these gentlemen are prepared to make any remarks, but I think the Society would be gratified to hear observations from any one of them upon the paper and the letters that have been read. I confess to have been impressed with the statement of Mr. Evans, that the earthquake element has not been duly considered by those who advocate the construction of a canal with locks, and as there are several gentlemen here who must know a great deal about the effect of earthquakes upon the Isthmus, I think we would all be very much gratified to know what they think of this objection. I should also say, in this connection, that Mr. Evans transmitted to me to-day a copy of a long letter in favor of the San Blas route, addressed to a member of the Paris Congress, which letter we will publish in our Bulletin. He accompanied this communication with a private note, containing a remark which I think I may take the liberty of quoting. It is this : "I have given my opinion as to the best route against my own private interest, and have no interest of any kind in the San Blas route." I will now take the liberty of asking Mr. Menocal what he thinks of Mr. Evans' objection, that the constant occurrence of earthquakes will have the effect on the Isthmus of warping, dislocating, or rendering otherwise unmanageable the heavy wooden gates of locks, and would add, that we would like to hear from him upon any of the questions involved in the consideration of this subject, for there is no gentleman present whose opinion is entitled to greater weight.

Responding to the invitation of the President, Mr. A. G. **MENOCAL**, Civil Engineer, U. S. Navy, said :

I am not prepared to make a speech in regard to the Nicaragua route, or any of the routes, but I will try to answer some of the objections raised by the letters just read. In regard to the earthquakes, I have to confess that earthquakes are very frequent in Nicaragua, but they are only slight shocks, that never did any damage to life or property, or in any way altered the levels of the waters in the lakes, rivers, and wells. And, I would ask, what damage could such earthquakes do the locks of a canal that would be of such serious character as to be regarded in the light of affecting the questions of the construction and maintenance of the work? It might crack the walls, but that damage could be easily repaired. But what effect, on the other hand, would earthquakes have upon such a tunnel as that proposed on the Panama route,—one an hundred feet wide and one hundred and sixty-eight feet high, as proposed. And we have them very near Panama sometimes. Only a year ago they had an earthquake in Santandea, where a whole town was destroyed, and fifteen hundred lives lost by it.

In regard to the objection of Mr. Appleton, concerning the locks necessary on the Nicaragua route, all admit that a tide lock will be a necessity of the route he advocates, and this will restrict the capacity of the canal as much as any number of locks along the route. If it takes a vessel an hour to go through the tide lock, it will take a dozen hours for twelve vessels to pass, irrespective of what the conditions beyond may be.

With regard to the liability of locks to get out of order, I think the American engineers are the ones who should speak least of that objection. Locks are in constant use on the canals of England, of Holland, of France, in fact all over Europe and in this country, and their working is no longer a thing of speculation and theory. The locks have been in use a great many years in the North Sea canal, and the engineers of that canal, though friends of M. de Lesseps, and advocates of a sea level route for an interoceanic ship canal, admitted that they could pass a ship every hour through the locks proposed on the Nicaragua route. That would carry all the tonnage through the canal that will be wanted.

The Nicaragua canal, I claim, could be built for one-third as much as that by the San Blas route ; not that I admit that the latter is practicable, but assuming for the present the claim of its advocates that it is. I think, from an engineering point of view, that the San Blas route is impracticable ; but suppose its difficulties could be overcome, it would cost three times as much as the Nicaragua canal, which will answer all the demands of trade just as well. Of the latter, nature has provided a great part already in lake and river, in which a steamer can go at full speed, and the portion remaining, the sixty-one miles of canal that will have to be constructed, is what should, fairly, be compared with the San Blas route. On that portion, sailing vessels will have to be towed, but so will they on the other. On Lake Nicaragua they can take advantage of the winds, the same as if at sea. But, in considering the San Blas route, the long towage out of the Bay of Panama to the Pacific must be taken into account, and should properly be added to the estimated length of that canal. It may be all very well for vessels that pass through, but what about vessels coming to the canal from the Pacific side ? How are they to convey an intimation, upon their arrival at the bay, to the canal officials, that they desire to be towed in ? It would be necessary to keep steam pilot boats constantly on the look out for such vessels. The difficulties of navigation on the San Blas route would be at least equal to those on the Nicaragua route.

CHIEF-JUSTICE DALY : How about harbors at either end of the Nicaragua route ?

MR. MENOCAL : We would have to build two harbors, one at each end of the Nicaragua route, but their expense would not be very great. The item of harbor improvement is covered in the estimate stated by Rear-Admiral Ammen. The plans have been submitted to several commissions of engineers, and fully approved, and the Paris Congress approved of them entirely, without any criticism.

I have no doubt that when M. de Lesseps arrives at Aspinwall, the information he will there receive concerning the recent floods of the River Chagres, will satisfy him of the impracticability of the Panama canal. As I stated at the Paris Congress, that river sometimes rises thirty-six to forty feet above the level of the sea at low water. The effect of this has already been clearly stated in Rear-Admiral Ammen's paper. When I stated this fact at the Paris Congress, it was doubted, and I was asked if my information was from actual surveys, or was only gleaned from the statements of the natives. It was, I said, from actual surveys ; yet they insisted that the River Chagres only rose seven metres. Now, they can satisfy themselves of the fact that I stated. During the last flood the river has risen forty feet. The town of Gatun was partially carried away, and parts of the railroad were submerged to a depth of several feet, during eight or ten days, by the floods.

I might remark on the difficulty of building a tunnel such as will be required on the San Blas route; but a discussion of the engineering difficulties to be apprehended would take a long time and hardly be understood. The great difficulty will be the making of excavations below the level of the sea. I have very carefully examined what takes place in the wells, and in the gold and silver mines and other excavations in that country, and I say that as soon as we reach about one hundred feet below the surface of the ground, the filtrations become so great that many of the richest silver mines have to be abandoned, because pumps could not be obtained of power and capacity sufficient to keep them dry. Through the loose disordered masses, the results of volcanic action, that make up the Isthmus, water filtrates with the greatest ease everywhere, and in great quantities. At the summit of the Panama railroad, its highest point, which is 282 feet above the level of the sea, there is a spring of water that supplies all the engines on the road, and in addition so far exceeds the demands upon it, that it runs down the gutters on both sides of the road.

What then will be the effect of digging below the level of the sea? From my knowledge of the geological formation of the Isthmus, I believe that, so far from encountering solid and regular strata, as they suppose, they will meet with all kinds of materials—limestone, trap-rock, sand, conglomerate volcanic deposits—everything, indeed, without regularity, and in the most bewildering variety, even within the narrowest limits. I have seen workmen there, in the digging of a well to a depth of no more than fifty feet, go through ten different kinds of materials.

CHIEF-JUSTICE DALY: Do you know the character of the rock through which it is proposed to cut the tunnel on the San Blas route?

MR. MENOCAL: I cannot say I know it positively, further than my well-grounded knowledge of the geological formations generally throughout that country assures me that, instead of one regular and consistent character of rock, will be found many different varieties. It has been said that the mountain through which the San Blas tunnel is proposed, is a solid mass of granite, but that I believe to be an error, and I should not be surprised if we found there a soft limestone, such as we find at the headwaters of the River Chagres, not far from that route.

The President then called upon Mr. JOHN BOGART, Secretary of the Society of Civil Engineers, who said: I think the majority of the engineers are still wanting a little more information in regard to the Panama and San Blas routes. The surveys made by Mr. Menocal at Nicaragua have been very full, and we are thoroughly well informed as regards the difficulties to be met there, and the modes proposed for overcoming them, but, certainly, as has been shown by Mr. Evans's letter, the idea of a direct short route from ocean to ocean, strikes engineers as an excellent solution of the problem. The thing in the way is this great tunnel. It certainly is practicable for engineers to discover—if we can get, as Mr. Kelley suggests, a proper survey of the San Blas route—just what the character of the rock is. We hardly like to say that it would be impracticable to put a tunnel in there. It is a question, of course, of possibility, and therefore I think that most of us agree with the suggestion made by Mr. Kelley, that before we positively decide on this matter, we ought to know more thoroughly the character of the rock at the San Blas crossing of the range. The subject is large enough, I should say, Mr. President, to be discussed when we have more time. There are several engineers ere in the audience, whom I see, who, I am sure, could give us an interesting discussion of this subject, but it is rather late to-night to call on them.

Mr. T. Bailey Myers moved that the discussion of this important question be continued by opening the rooms of the Society for that purpose on stated evenings, to be hereafter assigned.

In putting the motion, CHIEF JUSTICE DALY spoke as follows:

The Council having felt that, as this is a great international question, in the proper disposition of which we have as deep an interest, and perhaps deeper than any other nation, it is the duty of the American Geographical Society to acquire and diffuse as much information as can be procured, and to have the question of the best route discussed, as far as it can be, upon the ascertained facts. With this view, it is the wish of the Council to continue the discussion at the rooms of the Society, where, without any present limits as to time, the fullest opportunity can be afforded for the expression of views, and where everything that is said can be taken down and published in our Bulletin. This duty seems especially to devolve upon us more than any other American institution, for the reason, among others, that we have greater facilities than any other body in the country, with perhaps the exception of the Smithsonian Institution, for disseminating throughout the world the information elicited by such an investigation. We appreciate the necessity for, and therefore propose, having a more full examination of the comparative merits of the different routes than took place at the Paris Congress, which, I am free to say, was hardly a discussion at all; in which a very positive conclusion was declared by a vote of the majority of the body, with certainly very little preliminary investigation. We, on the contrary, think that it is a great, important and practical question, in which every opportunity should be offered for a more thorough examination and discussion of it than has yet taken place, and it is our purpose that this shall be done, as far as it is in our power to accomplish it. We intend, therefore, if the body of the Society approve, to continue what we have commenced to-night at the rooms of the Society, upon stated evenings, until all that can be done in this way has been done, assuming that those only will take part in it who have made the subject a matter of special investigation, who have some information of practical value to communicate, or views to express upon the ascertained facts; that it is not to be limited to an oral discussion, but open to the reception and consideration of any written communications upon the subject that any one may think proper to make. The question to be first settled—which is the most practicable route, under all the circumstances—is, in my judgment, a question for civil engineers and physical geographers, and not for congresses.

Such a question is not in a condition for final decision until all the explorations and surveys have been made, which the present state of our knowledge indicates should be made. We have done more in the way of explorations and surveys to ascertain the best route for the canal than any other country, at least so far as respects the cost, completeness, and value of the surveys, and we are naturally, therefore, not very much impressed—I say it in no spirit of discourtesy—with the action of a body coming together at Paris under the name of an International Congress, undertaking to dictate for the whole commercial world exactly where the canal shall be built, upon the report of two naval officers. I say this not in review of reports by Lieuts. Wyse and Reclus, or of the route adopted by a vote of the majority of the Congress, but simply as dissenting from this mode of attempting to foreclose all future inquiry upon the subject, and to give, by a preliminary proceeding of this nature, a kind of international sanction to the inauguration of what was simply a commercial enterprise. When it shall be fully and exhaustively ascertained what is the true route, in view of the general interest of commerce, the facilities for the construction of the canal, the outlay that will be required to make it a satisfactory and permanent work, and what security it may reasonably be expected it will afford for the capital invested in it, and for a moderate interest upon that capital—when, I say, all this is ascertained, the question of the canal will be settled without the instrumentality of international conventions or congresses, for the commercial world is pretty well agreed upon its utility, and the conviction is now very general that every year of the world's progress will but render more apparent its indispensable necessity. When all the information that can be gathered is obtained and duly weighed, commercial sagacity will determine whether the canal should be built, and where it should be built, and if it is to be, commercial enterprise will, in my judgment, find the means of doing it. This, as I understand it, is the American view of the question, and we are a practical people, accustomed to handle great enterprises, and in doing so, to possess ourselves first of all the facts before deciding what to do.

On motion of Mr. Jas. T. Gardner, seconded by Mr. Francis A. Stout, a vote of thanks was tendered to Rear-Admiral Ammen for the paper furnished by him, and a copy requested for publication by the Society. Carried.

APPENDIX A.

Proceedings in the General Session of the Canal Congress in Paris, May 23, *and in the 4th Commission, May* 26, 1879.

(Report by Rear-Admiral DANIEL AMMEN, U. S. N., Delegate of the United States Government to the Paris Congress.)

A MEMBER : I see that the Congress is drawing to its close. It will soon be called upon to decide between the different projects which have been submitted to it.

Shall the canal pass through Lake Nicaragua, or by way of Panama?

I beg leave to recommend the Atrato project to the attention of the President; leaving out the matter of expense and its technical question, I believe that it would have advantages for the interests of the country.

M. DE LESSEPS*: I would ask that you will be kind enough to present your observations to the commission charged with the examination of the question.

The representative of the Fifth Commission has now the floor.

THE SECRETARY OF THE FIFTH COMMISSION : The Fifth Commission had announced its report for to-day's session ; it met yesterday, and, after discussion, became convinced that it would be impossible to hand in its report before being fully advised of the decision which the Statistical Commission will adopt. This commission has informed us that they will complete their decisions at the sitting of to-morrow, Saturday. We have been obliged, therefore, to adjourn until the communication of the decision which will be made at that session.

M. DE LESSEPS : We will have a general session, then, next Tuesday, at 9 o'clock, to hear the different reports before the closing session, which will certainly take place on Thursday evening, at 9.

Now, gentlemen, permit me, as the President, to make a *resumé* of what has been done at the sessions of the Congress. You have heard the different reports which have been laid before you. What strikes us the most is the enthusiasm of the United States of America in favor of locating a canal at Panama ; they have been at considerable expense in sending out explorers to that

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* The President of the Congress.

Isthmus. It is unquestionable that America has hereby given us proof of her impartiality, and of her devotion [to the interests of a canal]. Let no one, hereafter, come to tell us that she does not wish a canal because she has a railroad. Admiral Ammen and Commander Selfridge, in their study of the projects, have expressed to us the desire to come to an understanding in order to secure something practicable.

Commander Selfridge has presented to us his plan for the Napipi-Atrato route—a plan without locks, except the two by which to descend from the level of the Atrato to the level of the Pacific. M. Wyse and his companions have reported on the mission which they undertook. Of the seven who went out, four died in those wilds, where one cannot advance a step except with hatchet in hand. They have at length returned, and have had the frankness to declare to us that, in the countries which they have just explored, a canal is impossible. When I saw them, it was in company with Monsieur La Valley, our illustrious Suez engineer, who has already designed for us so many machines, and who, in like circumstances, will well know how to invent new ones. I have consulted M. La Valley, and he has replied that the decision would be for a canal *à niveau*—that this would be the general opinion. I shall permit myself to sustain this opinion. Although I am not an engineer, my experience has often served me in this matter. It is very necessary to decide quickly ; if we should occasion delay, we will be the cause of great injury to commerce.

The most distinguished engineers of France have written some articles on this subject, which you have been able to read in the *Revue des Deux Mondes*. Some of them are in favor of a canal with fifteen locks, that is to say, twice as many as any one has already constructed in a work of this kind ; and this for the very simple reason, that they think it impossible to construct a tunnel. Moreover, I learned a fortnight ago that, as the result of the soundings very recently made, we cannot count upon an outlet from the canal into the Pacific; but, at this day, when dredgers have come into use, we have learned by the regimen of waters that what could not be done some years ago, is now perfectly practicable. It would have happened so to us at Suez (*i. e.*, we would not have an outlet there) if we had left our harbors without cleaning them out. God only knows at what we should have arrived in a century or two more; we have learned now to secure the equilibrium of the waters.

I do not wish to interpose the least difficulty in the labors of the Technical Commission. The savants have the means of foreseeing very many things, but there are some facts which are incontrovertible. I will ask the commission not to formulate any resolutions which could arrest certain plans. I would wish them to say only Yes or No; whether it appears to them possible to construct a canal *à niveau*, which seems to be the desideratum of the whole world. M. La Valley has studied that question of a tunnel; he believes it clearly practicable. It is, he says, only a question of expense.

I will not enter into the scientific question. I will only ask the Technical Commission to tell us precisely what would be the expense of a canal *à niveau;* what estimates can be made of that expense, and especially what the cost will be in the future (after construction) for canals *à niveau*, or for those with locks. Governments can en-encourage such enterprises; they cannot execute them. It is the public then on whom we must call, and when you come before them, they will ask of you (if it is a canal with locks) what will be the expense in the future.

I will express my opinion. I consider that a canal with locks would retard navigation. From the experience we have had at Suez, a ship must not now be delayed. There are a thousand Philistines there who can load a ship of 400 tons in an hour. It is to be remembered, also, that it costs a ship of a thousand tons, 2,000 francs for every day's delay. I have often been consulted on this subject; I have always replied, by dispatch, that ships must not be delayed in their passage; they are informed that it will be well for them to wait the rise of the tide when they cannot be sure of their being able to steer satisfactorily. The larger number of them, in spite of the delay, prefer to wait some hours for the tide. This is certainly an obstacle, and we thought of remedying it at Suez by means of tide locks; but we have been obliged to abandon that idea. I go every year to Suez. I have often met there with large ships which were passing with the ebb tide because they were in haste; I have witnessed the slowness of their sailing. We must not forget that the large vessels which come from England must make their voyage in twenty-one days. I have often seen these English vessels of 2,500 tons sheltering an entire regiment. These brave people are on the deck, with their wives and children, for you know they never travel without them. We look on them from a distance; they look like anything but soldiers.

In my opinion we ought not to make a canal at Panama with locks, but *à niveau*—that is the opinion of the public whose organ I am.

Don Manuel M. Peralta: I have listened with the most profound respect to the opinion which M. de Lesseps has just expressed. It appears to me he has forgotten to say that the Government of the United States appointed a scientific commission of three members, and that these gentlemen successively examined the different projects, from the route by the Atrato to the passage through the great Lake Nicaragua, as well as the canal *à niveau*, with a tunnel alongside the railroad from Colon to Panama; but, after a long and very conscientious study, and repeated explorations, they decided that the plan of Commander Lull was preferable from a humanitarian point of view, since it would save a great many lives—a circumstance which had not been foreseen when the Panama railroad was built; and, besides, that by this route sailing vessels could always pass with favorable winds, which cannot be hoped for on other routes, especially at Panama. The American scientific commission decided on the Nicaragua route, since it was demonstrated that the Panama route was impossible. Is there no ground for taking its decision into consideration?

M. de Lesseps: The Government declared that there was no impossibility for a canal with locks, and that it could not assert that a canal *à niveau* was impossible. The Government, in its fairness, was absorbed in one idea only. It acted on the principle that nothing was impossible.

M. des Grand: Since a commission has been named, composed of members of the bureaus of the different sections, would it not be well that this commission meet to formulate a programme of questions to be resolved? A programme which can be distributed in time for us to reflect upon them before the last sitting of the Congress? In this way, instead of being limited to the one question, which is best of all the canals?—or which is the same as asking, which is the best of all the governments?—we can enlighten the public more by increasing the number of questions. I wish to say that what is understood to be the best of all the canals, is not, perhaps, that which costs the least.

M. de Lesseps: The different sections can send in their memoranda to the Technical Commission, which will examine all their plans.

M. des Grand: If we have before us this question only—Which is the best of the canals? I fear we shall not reach its solution.

M. de Lesseps: We shall reach it in time.

M. Des Grand: I address the Central Commission, composed of the President and the secretaries of all the committees, and I ask it to formulate a programme, to which the Technical Commission will have to reply.

M. DE LESSEPS: We cannot impose a programme on that commission.

M. RUELLE: I will limit myself to three questions, which I address to the Commission of Navigation, to facilitate the labor of the Technical Commission.

We have been told up to the present time that there would be tide locks. I wish the Commission of Navigation to pronounce clearly on this point, since on the construction or the non-construction of tide locks may depend a difference of height in the tunnel.

Then a second question as to the form, whether ovoid or elliptical: Which of these is most economical for constructing a tunnel, and in which does the arch offer the most resistance? I wish to know if the width necessary for the passage of sailing ships can accord with the elliptical form, and if we must be limited to a width of 22 metres for the tunnel.

My third question to the Commission of Navigation is this: What comparison can be made between the difficulties of a ship passing through several locks, and the passage of the same ship through a tunnel of a certain length? In a word, will a tunnel ten kilometres long present the same obstacles to navigation as the sailing of a ship through nine or ten locks?

M. VOISIN BEY: From the questions which M. Ruelle addresses to the Commission of Navigation, I wish to set aside the first one; that is, whether guard locks ought to be constructed on the Pacific side. I add that this question can be answered only among ourselves.

M. SIMONIN: As the Congress must close its sessions next Thursday, and as our Honorable President has just told us that we must examine the cost of a canal *à niveau*, whatever it may cost, I ask permission to present some observations precisely on what our President has just said. We who have met in this body are not only engineers, geographers, theoretical scientists; it has seemed to me that we are also manufacturers, seamen and business men, and in the preceding general session our Honorable President said that in this matter it was not necessary to have the assistance of Government, and that we must address ourselves to the public only. Now, it has been announced that the transit of the future canal will reach the figures of six millions of tons, which I consider a very large maximum, and I have the right to so regard it, if I compare it with the figure of three millions of tons passing through the Suez canal, which is an important point of the world's commerce. Whatever may be the importance of the Panama canal, I doubt whether it will ever exceed that which the Suez canal has attained. I doubt it for more than one reason, because the Suez canal leads to China, which represents more than seven hundred millions of people, while, in America, you can only count on markets representing scarcely one hundred millions. Including countries as far as the Straits of Magellan, you will not have the millions of China. I believe, then, that the figure of six millions of tons, which you have fixed upon as an average, is exaggerated. Since we ought to treat it simply as a business affair, we should correct this estimate. We are going to make it an affair of the long future, as M. de Lesseps said ; but I believe that this would be to proceed on a very bad principle. We are going to adopt the canal *à niveau*, cost what it may, even though it should be five milliards —the estimate which has been made by a person of great authority in the United States. I say that we should examine the question from another point of view. We should inquire what a canal with locks might be ; besides asking specialists how many ships could pass through these locks in twenty-four hours—whether a sufficient number could pass for the number of tons which has been just spoken of. I am not the advocate of any company or any canal ; I have no reason to adopt one system rather than another ; but I do not wish that we should go out from this body with a negative vote. If we decide for a canal which would be impracticable, it would be unfortunate. We ought to treat the question as business men. It is necessary that this canal shall give large dividends to its stockholders. Without that we shall have played a singular part. I desire that our Honorable President will tell me if I have misunderstood him when he asked the Technical Commission to decide for a canal at any cost, provided it was *à niveau.*

M. DE LESSEPS : I have said that the commission would pronounce for one canal or another. We must decide. We ought not to go out from this body without making a decision.

M. SPÉMENT : I would remark to the assembly that we were already acquainted with the opinion of M. de Lesseps. He said in the Geographical Congress of 1875 that he had always advocated the use of canals *à niveau* everywhere, where their construction had been shown to him possible. I believe he thinks a canal *à niveau* would be preferable via Panama. If that should be impossible there, we must go to Nicaragua.

M. de Lesseps : Why not a fresh water canal——

M. Fontane : I ask leave to make a single observation in reply to M. Simonin. He said that he accepted the figure of 6,000,000 tons having to pass through the Interoceanic canal as a maximum. I wish simply to appeal to the patience of M. Simonin, and ask him to await the report which the President of the Statistical Commission, M. Levapem, will present in a few days to the assembly. He will find in this report all the elements necessary to form a definite opinion. He added that he accepted the figure of 6,000,000 of tons as a very large maximum, because there were but 3,000,000 of tons which passed through the Suez canal. I desire to recall to the Congress, that at its first meeting, in a report which I had the honor to present, I stated precisely the reason why the Suez canal has now a traffic of 3,000,000 tons. It is simply because steam navigation almost alone can properly utilize the Suez canal, and the shipbuilders cannot make enough steam vessels to carry on the traffic which exists. I showed by official figures that the traffic between the western and the eastern world through the Suez canal would reach 10,000,000 tons. Consequently, the figure of 6,000,000 tons that M. Simonin considers as a maximum for an Interoceanic canal, comparing it with the 3,000,000 tons of the Suez canal, becomes almost a minimum, compared with 10,000,000 which could pass through the Suez canal.

A second opinion of M. Simonin bore upon the sum that the Panama canal might cost—a sum which is reckoned at some milliards ! We would like upon this point again to appeal to the patience of our honorable colleague, and ask him to await the developments of the report of the Technical Commission, charged with estimating the cost of the canal. I have wished simply to appeal to the patience of M. Simonin. It is perhaps asking too much.

M. Simonin : I do not see why on two occasions M. Fontane, my honorable colleague and friend, has made an appeal to my patience. It seems to me that I speak with much calmness, and that I have always given proof of much patience and tranquility ; consequently, M. Fontane has wished to be witty, but I do not admit his objection. As to the figures that I have made use of, I would be glad if he would be good enough to demonstrate to me that they are exaggerated. We are doing a work in the interest of humanity. I shall experience great satisfaction when 10,000,000 tons will have to pass through the canal we desire to open.

The figures that I have cited have been made by conscientious persons; show me that we are wrong—I ask nothing better; but it is useless to occupy the attention of so numerous and busy an assemblage in making personal questions.

M. DE LESSEPS: There is nothing personal in that question, in what has been said ; it has only been the occasion for us to learn the opinions of those in listening to whom we have always great pleasure. M. Simonin has said that we have ten francs, since the Suez canal has been opened to navigation, and that, considering the number of vessels which pass through the canal, we had a return of 10 per cent. In truth, we have already received large returns, and we have been obliged to reduce our tariffs. Through whatever route the Panama canal will pass, it will shorten the distance more readily than the route of the Suez canal does. During the forty years that I have studied the question, I have always understood that, for a profit, it is necessary to receive at the least ten francs per ton; we can readily make the American canal pay double this, whatever may be the project that is brought about. These are considerations that one is very glad to know for the future.

COMMANDER SELFRIDGE makes known to the assembly, through the interpreter, that the people of the United States have no preference for any project. Everyone in America is convinced of the special competence of the Congress, and whatever may be the result, the nation will accept with eagerness all the decisions which may be taken here.

M. LAROUSSE : I will ask permission of the Congress to put another question in addition to those of M. Ruelle; it is to compare the difference of distances which the proposed canals would give, considering the principal regions which they would be called upon to benefit. It is certain that the Congress, in order to make a decision, will also have to estimate the time judged necessary to pass through the different canals, etc.; all of which points, I think, require some explanation.

M. EIFFEL : I desire that the Commission on Navigation will be good enough to give us some explanation upon the inconvenience of locks, if the number of them were reduced. In other words, would canals with locks present much less inconvenience with less than half the number of locks than by the plan as now presented ?

M. DE LESSEPS : If no other person wishes to speak, I will remind the assembly that our first general meeting will take place Tuesday next, at 9 A. M., to hear the reports of the First and Fifth Commissions, and that the closing session is fixed for Thursday.

The adjournment took place at 6.45 P. M.

VIEWS OF WALTON W. EVANS ON THE PROPOSED CANAL BETWEEN NORTH AND SOUTH AMERICA, ADDRESSED TO M. C. AUGUSTE VON HERNERT, FOR SUBMISSION TO THE PARIS CONGRESS.

BERLIN, *May* 9, 1879.

MONSIEUR C. AUGUSTE VON HERNERT.

My Dear Sir:—When I left Paris last November, I promised to write to you my views and opinions on the projected canal between North and South America, to run from the waters of the Atlantic to the waters of the Pacific, so that you could bring these opinions to the notice of that far-seeing and most intelligent cosmographer, Monsieur Le Count Ferdinand de Lesseps, at the Congress which is to assemble in Paris this month, to consider and discuss the subject of an Interoceanic Canal. I should have written this letter before, but for my long sickness with Roman fever in Egypt.

I will not attempt to discuss or offer opinions on the traffic that this canal will command, or the amount of tonnage that will pass through it, or the amount of benefit it will be to those nations interested in it, for they have been most thoroughly discussed and written on, and tables of tonnage made out by most competent compilers of statistics in both America and Europe. They all agree in the great importance and benefit to commerce that will result from the construction of this canal. I think that they all agree in one important point, namely, that the direct returns for the use of the canal will make it a commercial success, and I think that every one who has studied the subject will admit that the indirect returns to the three great commercial maritime powers, England, France and the United States, must be immense. The isthmus that divides North from South America has been for ages looked upon as a point or region that must some day be of great commercial importance. The Spaniards, in the day of their great power, made it a capital offense to speak of or discuss the matter of a canal between the two oceans. That long-headed Scotchman, William Patterson, the founder of the Bank of England, established a colony on the Isthmus of Darien, at Caledonia Bay, and would no doubt have made it a place of great commercial importance, but for the war waged on him by the king of Spain. Backed by all the power and influence of the king of England, he and his followers were driven from there, dying from hunger, and from that time to this the Mandingo

Indians, a tribe of about 800 souls, have held that region, as the supreme power, against all comers. William Patterson established his colony with the firm belief that in time it would be one of the greatest commercial centres in the world. There were over thirty pamphlets and papers published before the year 1700 on the general features connected with this colony and region. They all, I think, agreed in the healthiness of the climate and the productions of the soil. No man that I know of has ever been allowed to cross the isthmus at this point for nearly two hundred years without the consent of the Mandingo Indians, except Doctor Cullen. I hold that a full and complete survey of the Darien route from the Bay of Caledonia direct to the Gulf of San Miguel, or some navigable point on the Savanna river, has never been made with the view of tunneling the ridge which is met with near to the Bay of Caledonia. The examination of this route by my friend Captain (now Admiral) Provost, R. N., also the second exploration of part of the route by L. Gisborne, C. E., and also the careful survey of this route by Captain Selfridge, U. S. N., have nothing in them to condemn the route unless it becomes a settled question that the canal must be built without resort to tunneling. I fear very much that the United States government have decided to adopt the Nicaraguan route as the best for this great enterprise. I cannot but look on this as a great error. I will in as few words as possible attempt to explain my reasons for considering this an error, and then give my own opinion on what route should be adopted. I have taken much interest in this matter, and studied it with care for more than a quarter of a century.

Before I was born, and that includes more than six decades of time, the people of the United States looked forward to the time when they could enjoy the benefits resulting from a route to China and the east, by passing through a canal to be cut across the Isthmus of Panama, and at the same time contemplated the possession of the Sandwich Islands as a stopping place on the route from Panama to the mouth of the great Yang-tze-kiang river, in China. To show how great errors may exist in reference to geographical relative positions, I would state that there was not probably a man interested in the subject that knew that the Sandwich islands were not by two thousand miles in the line of the shortest route from Panama to China, and probably but few men in the world knew that the most direct route, irrespective of land and water, from Panama to any point in China, would pass to the east of San Francisco, and in traveling the great circle pass far to the north of the Sandwich islands. It may be asked what has this to do with an Isthmus canal? It has not much, but it shows, *cœteris paribus*, the most northerly route for the canal is the best, considering China and Japan as the objective points. There is another point in connection with a route to the east by way of the canal, which has not been touched on, as far as I have seen, in any recent reports or writings; it is *the pacific character of the Pacific ocean.*

It is now nearly thirty years since the British government published an elaborate and apparently exhaustive report on mail routes from England to the east, and discussed or brought to the attention of the public not only the time occupied and cost of existing routes, but also other routes that might some day be occupied. Admiral Moresby, R.N., then in command of the British fleet in the Pacific, brought this report to me to read, and said the author, in discussing the Panama route, had not said a word in reference to a most important feature—the pacific character of the Pacific ocean. I beg you to excuse my digression from the main question—the canal. I will return to it and try to stick to it.

It is now some years since the Congress of the United States authorized the President to appoint a commission to examine and report on an Isthmus canal. The President selected three most eminent men to form this commission—General Humphreys, the Chief of Engineers of the United States; Captain Carlisle Patterson, U. S. N., Chief of Coast Survey; and Commodore Ammen, U. S. N., all men of great ability and reliability in their professions, and in the works that have been intrusted to their charge; but none of them were civil engineers, nor had they ever any connection with tunnels. Under their direction and superintendence, a number of surveys were made of probable, possible and historical routes, routes that were said to possess favorable features, and routes that had been partially examined before. No one can read the long, elaborate and illustrated reports made by the commanders of these survey expeditions without being struck with the great amount of labor and fatigue these surveyors went through in this tropical region, where the heat is intense, vegetation dense, matted and thorny, insect life pestiferous in the extreme, and where the rain comes down much of the time in a deluge, as if the heavens had been burst asunder ; they deserve all credit for the display of indefatigable spirits that carried them through their arduous labors. There appears to have been two ruling and governing points in the minds of these commissioners in conducting their surveys and in making up their final conclusions :

First.—That the route to be adopted, was the one found to be the cheapest to construct.

Second.—That routes requiring tunnels must be ignored, and in view of these points they concluded to report in favor of the Nicaragua route.

I once thought the Nicaragua route was *the* route, but on more study and reflection, I came to different conclusions:

First.—That the subject is too important to be decided by the matter of first cost.

Second.—That the Nicaragua route is too long, requires too much locking up and down, is deficient in good harbors at both ends, and is particularly unhealthy at Greytown, at the mouth of the San Juan river, where the Gulf terminus must be.

It strikes me that the United States will not be in an enviable position if it guarantees its credit to the amount of fifty millions of dollars, or more, to a canal company, to build a canal on the Nicaragua route, and then finds that the world has awakened to the importance of the subject, and demands that a canal shall be cut on the shortest route to be found between the two oceans. This route is the San Blas route. From the Bay of San Blas on the Atlantic side to the Bay of Panama on the Pacific side, the distance is only thirty miles ; probably it is less on a direct line. This route requires a tunnel of nine or ten miles long ; this is the stumbling block that appears to be the insurmountable object in the minds of many. But it ought not to be, in this age of steam drills and improved explosive compounds. If the Spaniards could cut the *desaguadero* (a work which Humboldt called the greatest work of human hands), two hundred years ago, in Mexico, merely as a precaution to save the city in case of a great flood (this desaguadero was an open cut, and as I understand the dimensions it required three and a half times as many cubic metres of rock to be removed, as it would require to cut a canal tunnel ten miles long, 150 feet deep and 80 feet wide), surely we in this age of invention and great mechanical undertakings should not shrink in fright from a ship-canal tunnel ten miles long, and particularly when we look around and see the Mont Cenis tunnel completed, the St. Gothard tunnel nearly completed, and the Simplon tunnel seriously contemplated, all of nearly the same length as the ship tunnel in question, all connected with other severe features in the railway lines they are on, all for the limited traffic of a railway, and all for what might in comparison be called a local business; while the Isthmus canal tunnel, and the canal itself, is the greatest project before the world at the present day, and is but a small link in a great net-work of ocean navigation, extending for thousands of miles in every direction, and to every nationality of any importance in the world. This little link in a great centre is left for man to construct, while all the rest to the uttermost parts of the earth have been built by the Supreme Being, and given to man for his use and benefit, free of cost for construction and repairs. Can it be that there is not spirit and will and pluck enough in the people of the 19th century to cut this little canal, open this highway, and bring the Orient closer to the doors of the Occident?

I have an idea that the location of this canal is of too great importance to commercial interests to be decided by the mere matter of first cost, and I further believe that if the merits and demerits of the Nicaragua route, and the San Blas route were laid before any great political economist, cosmographer or statician for a decision, and he was told that the former would cost fifty millions of dollars, and the latter one hundred and fifty millions, he would decide in favor of the latter. I do not wish to convey the idea that the San Blas route is going to cost any such amount as $150,000,000. I have a belief that if the works are directed by skilled, experienced and capable engineers, that the canal can be completed in the very best manner inside of $150,000,000, and that it can be made to pay a good interest on that sum. I am much pleased to see in a recent paper that Mr. Kelley, of New York, advocates the adoption of the the San Blas route. Mr. Kelley is entitled to great consideration in the discussion and settlement of the question, as he has devoted more time, attention and money to it than any other living man, having made under his direction, and at his sole cost, surveys of eight entire routes.

It is established by the surveys of Col. Totten, for the Panama railway, that the mean level of the two oceans is the same; that there is little or no tide on the Atlantic, but that there is a tide on the Pacific side of about 25 feet, or say 7.62 metres. This has been brought up as an argument against a tide-water canal across the Isthmus, namely, that a current would be created in the canal, injurious to it and to navigation. Let us examine this by the test of figures. The mean level of the two oceans being the same, there would be a period in each day when the waters of the Pacific would be 3.81 metres higher than the waters of the Atlantic, and another period when they would be 3.81 metres lower. Taking the canal to be 30 miles long, this gives at the moment of extreme elevation or depression of the Pacific a surface gradient of 0.127 metres per mile. This may be considered a most healthy gradient, and could be used to advantage in passing ships in either direction. The gradient of the Ganges canal in India was originally 18 inches to the mile, equal to 0.457 metres, but this was changed to 15 inches per mile, equal to 0.38 metres, and has been worked at that in either direction ever since its completion, and without difficulty or risk, as far as I know. This gradient is over three times the gradient that would exist in the Isthmus canal, if built as a tide-water canal, without any locks at either end. Earthquakes have been another cause for fear in constructing tunnels in this region, but I am convinced that such fears are groundless. As far as I can learn, this San Blas region is peculiarly free from earthquakes, while they are frequent at Panama, but not strong enough to topple over some arches and some tall stone buildings in that city that are in decay and about 200 years old. We have constructed arches and tunnels on the Oroya railway, in Peru, where earthquakes are frequent; there are 62 tunnels on that railway, one of them being at an elevation of 15,648 feet above the level of the sea, equal to 4,769 metres, and to this day I have not heard of any disturbance to arches in these tunnels from earthquakes. (The Summit tunnel and some others are not yet arched). I had constructed and erected in Peru, on a railway, an iron bridge with a central pier 252 feet in height, which has been in use six years without showing any movement from earthquakes or other causes. I had constructed and erected on a railway in Peru an iron bridge, which has cast-iron upper chords and posts; it has been in use over 24 years, and is still per-feet. It is in sight of Arica, which was entirely destroyed by the great earthquake of 1868. Near to this bridge lies the hull of the U. S. man-of-war *Wateree,* that was carried by the tidal wave of that earthquake over the railway and left in the sand. I have great faith in our being able to construct a tunnel for a ship canal that will be safe against the destructive effects of earthquakes. The advantages that a canal constructed on the San Blas route would have over one on the Nicaragua route, are :

First.—It would be only 30 miles long, while the other would be 181 miles long.

Second.—It would be a tide-water canal, while the other calls for locking up 107 feet, and down 107 feet.

Third.—It has a good harbor at the northern end, and facilities for constructing easily a good harbor at the Panama bay end, while the Nicaragua route has no harbor at either end.

Fourth.—It is a healthy region at the terminus, while the Nicaragua route must terminate in a notoriously unhealthy region on the eastern coast.

Fifth.—The cost of repairs and conservation must, I think, be greatly more in favor of the San Blas route than the ratio of length of the two routes, namely, 30 to 181; as the Nicaragua canal, except the lake part, will be more exposed to accident on account of the embankments, locks, and other mechanical structures on it.

Sixth.—The San Blas canal can be passed through in six or seven hours, while a Nicaragua canal would occupy five days or more in the transit.

The immense amount of rock to be excavated for a canal tunnel of ten miles in length, and the time taken to do it, will, no doubt, frighten some people not thoroughly acquainted with such works, but when compared as to time required, it should not be estimated (with railway tunnels as a basis of calculation) to consume time corresponding to the amount to be excavated, for it should take no more time to drive a mile of heading for a ship-canal tunnel than it takes to drive a mile of heading for a railway tunnel, and when the "heading" is once driven through, an army of men could be put to work on the whole length night and day ; and when they came to the springing line of the arch, or before that, the work ought to be done per cubic metre as cheaply as if it was in open cutting, or cheaper and quicker, as the frequent rains which fall on the Isthmus in vast quantity drive the men from their work for whole days at a time. This would not occur in the tunnel, nor would the tunnel be washed or filled in by these rains; the tunnel once cut and arched, would stand for ages without requiring repairs, or being subject to "breaks," as is so often the case with elevated "reaches" of canals, occasioning suspension of all traffic sometimes for weeks. The Nicaragua canal cannot be made entirely free from accidents of this kind, while a tide-water canal is positively free from all such trouble. I will now close this already too long document by stating what I would do if I were "king," and no one to say nay to my acts.

First.—I would make complete surveys of the two routes—the Caledonia bay route, and the San Blas route—to find which was preferable, as regards length of tunnel, and also in other points, such as harbors, total length of canal and drainage, etc., discarding all other routes as objectionable.

Second.—If I found the San Blas route to be the best of the two, I would buy the Panama railway and its concessions of all kinds.

Third.—I would get a charter from the Colombian government, allowing me to build, and if they did not give it on fair and reasonable terms, I would take possession of the route and ignore them altogether, for this route is in the possession of the San Blas Indians, as the Caledonia bay route is in the possession of the Mandingo Indians; who have held it for 200 years against all the power of Spain and their successors; they are the supreme power, and if I could not conciliate them by gold and kind acts, I would exterminate them.

Fourth.—I would locate a direct straight line on the shortest route from San Blas to Panama bay, turning neither to right nor the left after getting through the tunnel, except to avoid the Chepo or Bayano river. This line, starting from San Blas, the most northerly point, will run to the east of south, and will intersect the Chepo or Bayano river, which comes from the east, and drains a considerable territory on the south slope of the mountains, nearly as far as Caledonia bay. It has been proposed to run the canal into this river, deepen its bed, and use its channel for the canal for ten miles, to where it debouches into Panama bay; but this I consider objectionable, as this river must be subject to floods, and no doubt brings down at times a large amount of debris from the mountains, chiefly vegetable matter. Through this whole region there lie on the ground great masses of immense trees, partially decayed. I would avoid this river by cutting a new channel for it for ten miles, or turn the canal to the right, after leaving the tunnel, and make it as free as possible from becoming a drain for anything.

Fifth.—I would send for Monsieur Favre, contractor for the St. Gothard Tunnel, who has more experience in great tunnels than any man now living, and make a contract with him, or some arrangement for the use of his brains or experience. I saw last summer at the St. Gothard tunnel better and more perfect arching than I ever saw before in a tunnel.

Sixth.—I would call together a convention of merchants, shipowners and engineers to decide on the dimensions of the canal and tunnel.

Seventh.—I would locate two tunnels, to be arched, half gothic in form, with a pier between them of 100 feet in width; but I would cut only one tunnel of 75 feet in width (22.86 ms.), sufficient to pass one ship at a time, and when the traffic warrants it cut the other tunnel.

Eighth.—I would drive this work night and day until it was completed and thrown open for the benefit of the world.

Ninth.—I would call on the governments of England, France and the United States to guarantee the bonds of a company to the whole amount of estimated cost; these governments to become the owners of the canal, and all belonging to it, at the end of 100 years, they paying original cost, as determined by a board of their own during construction.

Tenth.—I would make every man connected with this canal interested in its cost, the time it occupied to build, and his own time connected with it.

Eleventh.—I would insist on the whole work being completed in twelve years.

Twelfth.—I would do a great many other things, not necessary to mention here.

I remain, dear Sir,
Your obedient Servant,
WALTER W. EVANS,
Member of the Institute of Civil Engineers of England; of the American Society of Civil Engineers; of the Council of American Geographical Society,

P. S. May 10th.—I find that in the hurried and rambling way in which I wrote you a long letter last night, after my party had gone to bed, that I omitted to jot down one or two points of importance connected with this Isthmus canal matter. They may be looked upon as axioms—at least they run through my brain in that light. They are :

First.—The canal must be a sea-level canal, without locks, unless it may be decided to have a tide-water guard-lock at the Pacific end.

Second.—This canal must not be on a line of drainage, or in any valley subject to inundations.

It is but fair that I should give my reasons for using such strong expressions as "must be" and "must not be." I have been seven years connected with the construction of canals and in the severest school for canal engineering ever known in the United States ; I have had the direction of extensive engineering works in earthquake countries for eleven years, and I have no hesitation in asserting that any canal built in the earthquake country that exists where the Isthmus canal must be built, would soon be rendered useless, if locks are introduced, by earthquakes twisting and warping them, so that the gates could be neither shut or opened. It is a very common occurrence in South America to have a house so twisted out of square that the doors cannot be opened or shut. When an earthquake happens in the night, every one—men, women and children—rush from the houses in their night-dresses before the second shock (the severe one) comes, so as not to get caught in their rooms and unable to get the doors open. To build canal locks with chambers of 75 to 80 feet wide, will call for the most mathematical accuracy in the construction of the gates to make them work at all. If they are warped by an earthquake, they could not be opened and shut.

To build an Isthmus canal in such valleys as the Chagres, on the Panama route, and the San Juan, on the Nicaragua route, would, in my opinion, be the extreme of folly. If the canal was not washed out entirely and rendered utterly worthless, it would require so immense and never-ending expenses for repairs as to eat up all revenues received. You may depend on it that owners of large and fine vessels, freighted with valuable cargoes, will think twice before allowing their ships to enter such a canal as the Nicaragua canal must be if ever it is built.

Has any one ever estimated the number of large ocean vessels that could be passed through the Nicaragua canal each day ? The huge leviathans that now traverse every ocean are not children's toys; nor are they easily started or stopped, as I had occasion to notice in coming through the Suez canal within the past month in a Peninsular and Oriental steamer, over 400 feet long. Entering the canal from Lake Timsch, our steamer ran into the right bank, the stern swung round and fastened itself in the left bank. The next steamer from Bombay, of the same line, had the same thing happen, and broke off two blades of her propeller. I hope you will bring some of these points to the attention of the Congress that is about to assemble in Paris.

If any one wishes to see what destruction might happen to a canal constructed in a valley on a line of drainage, and depending for its efficiency on "locks" and "dams" as its chief features, let him take a trip up the Lehigh valley, in Pennsylvania, and there he will see (in a place where such floods occurred as are almost daily occurrences in the Nicaragua and Panama region) the ruins of what was once a most admirably constructed canal, having dams of best design and build, and locks of the greatest lift ever constructed. One single flood in the Lehigh river swept out to utter ruin every lock and dam, and almost "like the baseless fabric of a vision, left not a wreck behind." If any doubter, in search of further knowledge regarding the permanence and reliability of canals with elevated "reaches," wishes to store his mind with facts, let him take the records of the Erie canal, where the best "puddle walls" and the most carefully built embankments ever designed and constructed are to be found, and he will see the history of many accidents from floods and wash-outs that occasioned delays and vast expense; and if he has a reflecting brain, with a slight knowledge of the Isthmus region, the idea might dawn on it that such accidents happening in the San Juan valley of Nicaragua, or in the Chagres valley of Panama, could not be repaired as readily, as quickly and as cheaply by ten-fold as they could be in the state of New York.

If stone walls in cement are to be built along the whole length of the embankments of the Nicaragua canal, to prevent rats and roots from boring through and starting little leaks, that soon grow to destructive wash-outs, then the advocates of that route had better add a few more tens of millions to their estimate of cost. Such accidents cannot happen to a tide-water canal. And Count Ferdinand de Lesseps was correct when he said to me, in Paris, that whatever route we adopt, one thing is certain—it must be a sea-level canal.

REPORT OF W. E. JOHNSTON, M. D., DELEGATE OF THE AMERICAN GEOGRAPHICAL SOCIETY TO THE PARIS CONGRESS, ON THE PROCEEDINGS OF THE SAME:

I did not render you at the moment an account of the proceedings of the Interoceanic Canal Congress held in this city two months ago. I was not able at that time to do so.

The subscription has failed, but M. de Lesseps announces that the project is not abandoned, and that he is going to the United States to try to interest the people in the scheme.

As the agitation on the subject, therefore, is to be maintained, and perhaps transferred to the United States, you will need all the data on the subject it is possible to obtain.

For this reason, and because the American part in the affair has been perverted, I feel it to be a duty to go back and give you the history of the proceedings of the Congress and its accompanying incidents as I saw them.

As I have taken the liberty of informing you in previous letters, the French people had come to look upon this canal question as exclusively their own. For many years the press and the public men of the country had talked and acted as if they had a monopoly of the matter. No attention was paid to the efforts of the American government, nor to the surveys of our able naval officers; or, if they were referred to, it was to depreciate their value or to throw doubt on their sincerity. It was even charged in print that these officers were bribed by the railway companies to slur over their work, and not to find a feasible route.

In a country full of money seeking an outlet, this state of things naturally begot a multitude of schemes for an interoceanic canal. You would hardly believe how many people were spending their time and money the last few years on this for them empty bubble, the pretended inertia of the Americans all this time being attributed to the opposition of the railway companies.

All of these schemes were submitted to M. de Lesseps and were encouraged by him. He is the great canal digger; his influence with his countrymen is legitimate and universal; he is kindhearted and obliging, but he is ambitious also—perhaps not more so than other people—and appeared so anxious to attach his name to the successful company that he gave his consent to all.

But it was not till men with prominent names came forward that he announced publicly his sympathy and coöperation. These men were Messrs. Wyse, Turr and Bixio. Lieut. Wyse, of the French Navy, is a son of a former English minister at Athens, and his mother was a Princess Bonaparte of the Roman branch of the family. General Turr is a Hungarian, and married Lieut. Wyse's second sister. M. Bixio was a brother of the Minister Bixio, of the Provincial government of 1848. He died of fever on the isthmus.

These gentlemen, backed by some bankers and personal friends, made their first visit to the isthmus three years ago, and examined one of the Atrato routes. They came back sick, reported unfavorably, and after some months' consultation, in which M. de Lesseps took a large part, it was decided that Lieut. Wyse should return to the isthmus and look at the Panama route, with the view of making that the affair on which they were finally to settle, and as the affair to which the public in France would be most likely to subscribe.

The survey was made—how imperfectly was afterwards shown in the Congress by the abandonment of all the figures, and of even the plan; the party returned to Paris, and last winter the plan of campaign of putting through the Wyse scheme was organized.

An International Congress was to be called, so as to give authority to the scheme; M. de Lesseps was to preside at the Congress and issue the invitations, and as the President had the right to constitute the Congress as he saw fit, enough French members of the right sort were invited to counterbalance any opposition that might manifest itself. So far as Lieut. Wyse and party were concerned, they sought first to reimburse themselves for the losses already sustained, and for which they were responsible to certain bankers and friends, and this they hoped to do by forming a new company which would assume the responsibilities they had incurred.

This was the origin of the famous Congress. It was not, as you see, a very high-toned affair; it was not intended that it should be. The object was to get out of an old debt by creating a new one, to be shouldered by some one else. The digging of a Panama canal was a very distant and very problematic affair.

But it turned out that the Congress became a very serious and very grave affair. As eminent engineers from foreign countries began to arrive, the hope of carrying out the prepared programme diminished. The great satisfaction which was at first manifested at the prospect of having a large and respectable gathering, soon gave place to sad reflections and sad surmises. The arrival of the two eminent American authorities, Messrs. Ammen and Menocal, was a deathblow to their hopes, and although those two gentlemen were treated with the greatest consideration, it was felt by the leaders that their coming was a disaster, and that a new base of operations would have to be adopted.

There is nothing, in fact, more curious in the history of caucuses than the evolutions of this Congress.

Not only was the President of the Congress named in advance, but so also were the officers and the committees, and even the work the committees were to perform. Nothing, it was intended, was to be left to hazard. At the first meeting, at which were present the 136 members, and above 300 spectators interested in the subject, nothing was done or allowed to be done but the reading of the names of the members, the names of the committees and their presidents, and an indication of the work they were to do. The first meeting did not last an hour, no one had a word to say but the President and Secretary, and this very summary way of treating the distinguished guests who had come a long way to the "study" of the interoceanic canal project was climaxed at the end by the President hastily adjourning the meeting with the remark: "Gentlemen, we are going to rush this thing *à l'Amèricaine*: we shall get through by next Tuesday."

Thus not only was the Congress packed and manipulated so as to run through hastily and without fail the imperfect and impossible scheme of Lieut. Wyse, but the most distinguished and honorable experts from all parts of the world were invited to give the scheme their aid and to cover it with their responsibility.

It was hardly dignified, therefore, for men holding the high rank of government delegates to take their seat in a Congress which had been gotten up for a certain limited and well-defined object, and in which no proposition outside the programme stood the least chance of adoption.

Fortunately, the American government had given such instructions to its delegates as would meet just such an emergency: they were simply to furnish to the Congress, for its instruction, the facts and figures collected at the bureau in Washington, without pledging the government to anything. Their mission was a mission of good-will, and not of partisanship, and if the Congress did not benefit by it, the government of the United States and its delegates were not to blame.

When it came to the turn of Messrs. Ammen and Menocal to give their figures and estimates of the different routes, a complete revolution took place. The great body of able engineers, who had come to the Congress unpledged to any route, and who had come seriously to study the question without prejudice, were astounded to find that nobody in Europe knew anything about the question. The *exposé* of the American delegates was a revelation, in fact, to the whole Congress. The estimates of Lieut. Wyse were shown to be as fictitious as if made in Paris without ever having visited the isthmus.

From this moment the Congress became a real Congress and not a sham. The facts and figures of Messrs. Ammen and Menocal now formed the only basis to stand upon. It was transformed into a respectable Congress, with real data on which to base a scientific discussion. Three-fourths of the competent members declared that the surveys of Lieut. Wyse were worthless, and M. de Lesseps and the Wyse party were in consternation.

We were now brought face to face with the singular spectacle of a Congress which had become serious and honest, and which saw its way clear to the truth, and yet which was obliged to remain dishonest, and carry out the original plan, no matter by what means.

The reason of this singular anomaly is easily understood. M. de Lesseps, Lieut. Wyse, and the bankers behind them, were pledged to the Panama route, and could not adopt another. That was the French route; they had been long manufacturing enthusiasm for that route; the bankers and the public would not give a cent to any route that was not patronized by M. de Lesseps and Lieut. Wyse. So that to abandon that route was to abandon entirely for France the glory of cutting the interoceanic canal, and that was not to be thought of for a moment. They had been claiming, as I have already told you, for years the monopoly of this question; they claimed all the knowledge on the subject, and to back out now would be to lose all the money they had engaged in the scheme, all the money they expected to gain, which was a mountain, and to lose their popularity besides. The Congress would have been dissolved without a decision rather than to have adopted another than the French route.

But how was this accomplished? M. de Lesseps's galloping Congress was adjourned for several days; we heard no more of rushing the thing through *à l'Américaine;* they had to stop to change their base. Lieutenant Wyse, with such of the engineers as were pledged to his scheme, went to work in secret committee, and labored night and day till they elaborated a new plan, to cover as they thought the objections of Mr. Menocal, and with, of course, a much higher figure of costs. The committee having in charge the estimates on the probable receipts and expenditures of the canal, were instructed by the President to try and make the receipts cover the new estimate of costs, which they did with the greatest ease.

Again, the American engineers, backed this time by overwhelming arguments by Sir John Hawkshaw, showed that the plan was still defective; and again the Congress was adjourned to give time to the Wyse secret committee to get up new figures and a new plan. The Congress, which started off on a gallop, had first dropped into a trot, and was now at a walk. And all to allow Lieut. Wyse to prepare estimates on difficult details which he had never studied on the ground, and which, therefore, were only theoretical.

The majority of the engineers lost their interest in the proceedings from this moment, and became simple lookers-on, while the meeting relapsed back into its original character of a Congress for the benefit of Lieut. Wyse and his party.

The assembly was now in a crisis. On the one side were the engineers, on the other the business men and the speculators. It looked at one time as if the Congress, if called upon, would have voted for the plan of Mr. Menocal by Nicaragua. The charter of Mr. Wyse from the Colombian government exacts the building of the canal by the most economical route, and to build it by the dearest route is a violation, and a forfeiture of the charter. But these difficulties, which were pointed out to the Congress, no longer stopped the proceedings. The Wyse party had now offered their ultimatum, which was an open cut, without locks, and with *deversoirs*, or side canals, the whole to cost 250,000,000 of dollars, and to pay in receipts 18,000,000 of dollars a year.

At this point M. de Lesseps made a long speech. He is tenacious as well as able, and did not propose to suffer a defeat. He commenced by several propositions, which are true, as, for example, that in looking at the map Panama appears to be the right place for a canal; that this route already had a railroad, and a thriving city at each end, which would facilitate the construction of the canal; it could there be built without locks, in his opinion, which was a great desideratum. Finally, he made the statement, which was new, and rather astonishing, but which nevertheless produced a marked effect in favor of his project, that when he commenced the Suez canal many of the problems connected with it were unsolved, and looked dark, but that as they progressed, and difficulties crowded upon them, men of genius sprung up to meet and conquer the difficulties. The same, he said, would take place in this new enterprise. For every difficulty there would be found a man of genius capable of conquering it. As for the money, there was plenty in France; the enterprise was French, it would add largely to the glory of France, and the money was ready, waiting the opening of the subscription books.

The effect of this speech was enormous. The American engineers had shown that the Panama route, principally on account of the annual fall of twelve feet of rain, was impossible; that it never could be finished if commenced, nor made to pay a dividend if finished: it was all to no purpose; Lieut. Wyse and his committee had but to retire to their consultation-room to find at once in their own heads the figures necessary to head off Mr. Menocal's estimates. It was the game of "I see you, and go you one better," played by men who had no cards, but plenty of money.

The next day the last meeting and the final voting were to take place. The question had now been placed on national and patriotic ground; we had arrived at the moment of "sublime resolutions," of those "sublime resolutions" which have been the glory and the ridicule of France; they were going to carry hundreds of millions of money abroad for the good of mankind in general. It would cost much money, but the money they had; it would require men of genius, but these also they had; the absurd barrier which nature had thrown up between the two seas was going to fall before the force of French genius and the power of French money. It was impossible, even in the absence of any practicable figures, not to grow lachrymose over the Panama route.

Nevertheless, the intelligent chairman was not going to trust the vote to any hazard which could be avoided. He had decided, without consulting the meeting, that the voting should be nominal; that each member of the Congress should be called up in alphabetical order to declare by *yes* or *no* how he voted, with the privilege of explaining his vote by a word, but only by a word; and in case he had much to say, it should be said in writing, addressed to the secretary. By this method of open voting certain wavering Frenchmen were prevented from dodging an affirmative vote.

As the voting went on, certain delegates, by attempting to make speeches against the project and against the mode of voting, irritated M. de Lesseps to such a point that he suddenly exclaimed, for the first time, and to the astonishment of everybody, that he would take charge of the canal himself, and that they might be sure that if he took hold of it the canal would certainly be cut, and cut quickly, honestly and economically! This announcement electrified the house, not only because M. de Lesseps is much loved and is really the best man for the work, but because it was a plank of safety thrown to a scheme which was being saved with difficulty.

After this the voting was more cheerful, and, when finished, counted up 74 yeas, and 62 nays and abstentions, in a total of 136 registered delegates. When my name was called, I declared that I abstained from voting, on the ground that only one route was put to vote, and because none of the routes had been sufficiently studied. I hope that this course will meet with the approbation of your honorable society. Of the other American delegates present, six in number, three—Admiral Ammen, Mr. Menocal, and Professor Lawrence Smith—counted themselves with the abstainers, on the ground that the work of the Congress had not been sufficiently elaborated, while the other three voted in the affirmative.

If it be thought that the word " abstention " was too mild a word to be found in the mouths of American delegates, it must be stated in extenuation that these delegates were met and surrounded during their whole stay with such a large hospitality, they were so dined and fêted, that they will be excused for lacking the heart to look their entertainers in the face and pronounce so harsh a word as "no."

An analysis of the final vote will show that the able engineers who came to the Congress with their minds free from prejudice, and with a desire to arrive at the truth, are either to be found among the absentees, or among those who abstained from voting.

Thus, as the majority for the Wyse scheme was small, as the neutral experts were opposed to it, and as the Congress from beginning to end was manipulated in the interest of that scheme, it may be said that, in an international point of view, the decision of the Congress was no decision at all, and that it is without force and not binding.

Thus, too, although a great use is being made of this sanction of the Congress, and although the assembly in fact contained in its list of delegates many of the most distinguished engineers in the world, the whole affair was in reality a comedy of the most deplorable kind, and should have no weight whatever in any future measures it may be desirable to adopt.

Certainly there was no allusion to politics in the Congress, and the enterprise was honestly intended to be a purely financial one; but every one understood that the bankers who proposed to take the loan, intended to shove the shares into the hands of the people as rapidly as possible; that at the end of two or three years, when the company failed, as it certainly would, the French government, for motives of popularity, might be led to assume a responsibility in the affair, and then the American canal would stand exactly in the dangerous position in which the canal of Suez now stands, that is to say, with a large portion of its stock in the hands of a powerful government, waiting an opportunity when the protecting powers may be in trouble to utilize this stock as its personal interests may demand.

So well did M. de Lesseps understand the need of getting his stock into the hands of small holders, that he undertook at once a voyage through the provinces, to create popularity for it with the rural populations; because in a moment of distress these populations have a stronger hold on the sympathies of the government than the bankers or speculators. In these provincial tours he everywhere gave the impression that the governments of France and the United States were equally favorable to the enterprise; the flags of the two nations were everywhere united over his head when he spoke; and the following extract from one of his speeches, published in a provincial paper, is but a repetition of what he said at all the towns where he spoke: "The Monroe doctrine," he said, "has nothing to do with our enterprise, because it is a private affair, because it is international in its character, and, therefore, neutral. The opposition of the United States is not serious, because their representatives at the Congress declared that the United States came to the Congress to submit themselves to the verdict of the majority, and this verdict has been rendered in favor of the Panama route. Furthermore, the execution of the project cannot give rise to political complications, for the reason that the direct or private aid of any government has not been demanded."

I need not assure you, perhaps, that no authorized delegate of the American government made any assurance of the kind to the Congress, and that so far as I was concerned personally, I seized upon every occasion to assure the members that the American government, in the opinion of those who knew best, was opposed to the Panama route, because its engineers had shown that it was too costly, and, therefore, not practicable.

But the statements of M. de Lesseps, in his speeches, have been marked by such exaggerations as seriously to shake the public faith in his soundness of mind, and one French newspaper declares squarely that he has entered his dotage, and ought not to be trusted with other people's money.

Another French paper, the *France Financière*, stigmatizes the whole thing as a swindle, and as only a repetition of the transcontinental affair (for which General Fremont and Baron Boildeau were condemned to prison), and declares further that M. de Lesseps is in a fair way to compromise his honor and to tarnish his fair name.

Another paper, the *Crédit Maritime*, declares that the canal will cost so much that it will never pay dividends, that the government will be forced to interfere, and that from that time diplomatic trouble will commence. This paper adds that fortunately the concession of the Colombian government exacts (as I have already stated) that the most economical route should be adopted, and that steps have already been taken to annul the concession. These steps are being taken, of course, by the friends of rival routes, who were cavalierly treated by the Congress, and who desire a revision and a re-examination of all the routes.

In fine, the French have made a grave mistake in engaging themselves recklessly in a colossal enterprise about which they knew little, and this mistake is due in the first place to the fact that they were dazzled by the feat of digging the Suez canal, and by the possession of a great and popular authority in canal digging in the person of M. de Lesseps ; and, in the second place, to the circumstance that for many years past the press and the public men of the country have assiduously propagated the idea that France possessed the monopoly of this whole question.

Under the empire M. de Lesseps would not have been permitted to call a Congress, not even a well-intentioned Congress, on so grave a question, without first investigating, through the legation at Washington, the state of the question in the United States. The failure of this Congress will teach the people the salutary lesson that under the republic they must think for themselves, and not follow the lead of any man.

Paris, Aug. 15, 1879.

W. E. JOHNSTON, M.D.

THE NICARAGUA CANAL: Extracts from Mr. S. B. RUGGLES's Semi-Centennial Address at New Haven, July 27, 1864.

The picture of our fifty years would be singularly incomplete were it to omit Louis Napoleon, that " mysterious and inscrutable " sovereign, who mainly governs France by governing himself, and preëminently the most commanding object within our field of view at the present hour. Whatever ultimate designs he may entertain in respect to America, and how much soever we may reprobate his manner of reaching the throne, or his recent interference with the affairs of Mexico, we cannot close our eyes upon the unexampled success of his civil administration. He has certainly signalized his reign beyond that of any preceding ruler of France, by the permanent improvement and splendid embellishment of its cities, the vigorous prosecution of its works of inter-communication, the canalization of its rivers, the rapid increase of its commerce, and the immense augmentation of the pecuniary value of the empire * ; not to mention his political performances in the consolidation of Italy, and the recent remarka-

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* The value of the real and personal estate of France authoritatively stated in debate in the *Corps Legislatif,* May 7, 1864, was 249,000 millions of francs, about 46,000 millions of dollars. In 1852, it was about 124,000 millions of francs, showing an increase, in twelve years, of about 23,000 *millions of dollars.*

The taxed value of the real and personal property of the United States in 1850 was 7,135 millions of dollars. In 1860, 16,159 millions. Increase in ten years, 9,024 *millions of dollars.* During those epochs, the public works of both nations were vigorously prosecuted.

The $9,024,000 added to the pecuniary value of the United States, in the decade from 1850 to 1860, was occasioned largely by the increase of our population, shown by experience for seventy years to vary very little from 35 per cent. for every decade. The increase in the last decade from 23,191,176 to 31,445,089 (being 8,254,209), compared with the $9,024,000 increase of value, shows a rate of $1,093 (in metallic currency) for each additional inhabitant.

The increase of population for the present decade from 1860 to 1870, may possibly fall somewhat short of the previous rate, but will not probably be less than ten millions for the whole United States, or seven millions for the loyal states. The latter number, multiplied by only $800 (in metallic currency) for each additional inhabitant, would amount to 5,600 millions of dollars—nearly threefold our present national debt. All we require is an honest administration of our national resources—and a metallic basis for our national currency.

ble extension of the territory and power of France over the African coast of the Mediterranean. It may well be, that his very characteristic declaration, that "France makes it a point of honor to keep rivers and revolutions in their proper channels," *—condensing in a single phrase his whole policy at home and abroad,—has offended the lovers of the largest republican liberty, but every one will recognize his noble and comprehensive statesmanship, in seeking so earnestly not only to recover and reconstruct the canal of Suez, the work of Ptolemy and of Trajan, but to open through the central portion of America, by his proposed canal of Nicaragua, the way to the East Indies, which Columbus sought in vain to discover.

The fact does not seem to be generally known that Louis Napoleon, while a state prisoner of Louis Phillipe, and actually immured in the prison of Ham, deliberately signed a contract to construct the canal of Nicaragua, to pass vessels of 2,000 tons from ocean to ocean, and personally to expend on the work seventy-five millions of francs. It so happened that the progress of the public works of New York, with which I had been officially connected, having been unexpectedly and rather rudely stopped, I had gone to Europe; where my business was to ascertain whether France and England would join the United States in constructing an interoceanic canal through the Isthmus of Panama, to be free to all the nations of the world, and to be forever consecrated to peace. It was on the suggestion, and indeed at the request of the minister at Paris from Nicaragua, that I met Louis Napoleon, in London, in 1846, about a month after he had escaped from prison. To external observers, he certainly then appeared to be very far from the throne of France, so that the conversation between us was comparatively free and unrestrained, although his manner was at times just a little imperial. On asking him if he thought that his proposed canal would yield an adequate revenue on its cost, he answered with a princely air—"Perhaps not; but you *now see me out of my true position;* and I

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* This imperial sentence, so far as rivers are concerned, is a French paraphrase of Horace's compact description of the Tiber, controlled in its inundations by the vigorous arm of Augustus—"doctus iter melius." Every sovereign, ancient or modern, dignified by history as "the Great," has regarded the improvement of the rivers and the roads of his country, as a duty and an honor. Alexander the Great died at Babylon while clearing the Euphrates from obstructions.

"must do something worthy of the name I bear." He was then writing a pamphlet, in which he fully and very ably set forth, not only the commercial, but the high political importance of the proposed interoceanic canal. The pamphlet, a copy of which, bearing the autograph of the writer, is now before me, indicates so clearly the exalted objects which he then had in view, and which he has since acquired the power in some degree to accomplish, that I beg leave to read one or two brief extracts. They are of peculiar interest at the present time, not only in bringing boldly out the noblest features of the golden age of civilization we have just been reviewing, but also in manifesting the opinions then entertained by the present ruler of France in respect to the abolition of slavery, not alone in America, but throughout the civilized world.

"The geographical position of Constantinople," says this now imperial writer, "is such as rendered her the queen of the ancient world ; occupying, as she does, the central point between Europe, Asia and Africa, she could become the entrepôt of the commerce of all these countries, and obtain over them an immense preponderance ; for in politics, as in strategy, a central position always commands the circumference.

"This it what the proud city of Constantine could be, and this is what she is not, because, as Montesquieu says, God permitted that Turks should exist on earth, a people the most fit to possess uselessly a great empire.

"There exists in the New World a state as admirably situated as Constantinople, and we must say, up to the present time, *as uselessly occupied ;* we allude to the state of Nicaragua. As Constantinople is the centre of the ancient world, so is the town of Leon, or rather Massaqua, the centre of the new ; and if the tongue of land which separates its two lakes from the Pacific ocean were cut through, she would command, by her central position, the entire coast of North and South America. The state of Nicaragua can become, better than Constantinople, the necessary route for the great commerce of the world, and is destined to attain to an extraordinary degree of prosperity and grandeur."

"France, England, Holland, Russia and the United States have a great commercial interest in the establishment of a communication between the two oceans ; but England has, more than the other powers, a *political* interest in the execution of this project. England will see with pleasure Central America become a flourishing and powerful state, which will establish a balance of power, by creating in Spanish America a new centre of active enterprise, powerful enough to give rise to a great feeling of nationality, and to prevent, *by backing Mexico, any further encroachment from the north.*

"The prosperity of Central America is connected with the interests of civilization at large ; and the best means to promote the interests of humanity, is to knock down the barriers which separate men, races and nations. This course is pointed out to us by the Christain religion, as well as by the efforts of those great men who have at intervals appeared in the world. The Christain faith teaches us *that we are all brothers and that in the eye of God the slave is equal to his master*—as the Asiastic, the African and the Indian are alike equal to the European.

"On the other hand, the great men of the earth have, by their wars, commingled the various races of the world, and left behind them some of those imperishable monuments, which, in levelling mountains, opening forests, canalizing rivers, have a tendency to upset those obstacles which divide mankind, and to unite men in communities, communities in people, people in nations. War and commerce have civilized the world. The time for war has gone by; commerce alone pushes its conquests. Let us then open to it a new route; let us approximate the people of Oceanica and Australia to Europe; and let us make them partakers of the blessings of Christianity and civilization."

It would not fall within the scope of the present address, which seeks to review the men and the sovereigns of the last fifty years, not as potentialities, but as historical facts, with actual, visible results, to look beyond the present hour, or to enquire how far the reigning Emperor of France will probably carry into practical effect the enlightened and far-seeing views of the "Prisoner of Ham." They now apply not alone to Nicaragua, but emphatically to Mexico, as furnishing a more accessible and easier route for the great interoceanic channel which he then regarded as vouchsafing such blessings to all mankind, and especially to the colored races held in slavery.

Louis Napoleon is a thoughtful student of history, and, as such, wisely covetous of lasting fame. After announcing his purposes, so grandly Christian and philanthropic—and in full view, moreover, of the magnificent example hung high in the heavens by his great compeer in Russia, emancipating at a single stroke a population of more than twenty millions—can it be possible that he will so disregard the judgment of coming ages as to lend his aid at this late hour to blacken the American continent with the blight of African bondage ; still less that he will openly uphold and abet the unholy and savage effort to establish on the ruins of our young republic a barbarian power proclaiming slavery as its corner-stone ?

Louis Napoleon is, moreover, a mathematician, profoundly versed in the knowledge of quantities, material and political. Will he forget the material and political science practically taught by the first Napoleon in ceding to the American republic nearly one-half of its widespread continental area, for the very purpose of building up in this western hemisphere a continental power of sufficient weight to preserve the political equilibrium of the globe, which the constantly increasing possessions of England were disturbing ?

DISCUSSION UPON THE PROPOSED INTEROCEANIC SHIP CANAL.

Special Meeting, Monday evening, December 15, 1879, at No. 11 West 29th Street, Chief Justice C. P. Daly presiding.

Present,—Gen. Geo. W. Cullum, U.S.A.; Gen. Q. A. Gillmore, U.S.A.; Signor de Franco; Horatio Seymour, State Engineer of New York, and James T. Gardner, Director of the State Survey; Major Sidney F. Shelbourne; Col. T. Bailey Myers; F. A. P. Barnard, President of Columbia College; Messrs. A. G. Menocal, Wm. H. Webb, A. L. Ford, A. J. Cotheal, Wm. L. Elseffer, Elial F. Hall, Wm. H. H. Moore, Cyrus Butler, D. Torrey, John Bogart, Secretary of the Society of Civil Engineers, and others.

Chief Justice Daly: It was suggested, at the last meeting of the Society at which this subject was considered, that it should be continued at the rooms of the Society. The fact that several gentlemen who are familiar with the matter are now in the city, and are about to leave in a day or two, made it necessary that we should call a meeting within so short a period as left no possibility of sending individual notices to our members, as is our custom. All we could do was to give notice in the evening papers to-day, and I am gratified to see that there is a larger attendance than we had reason to expect. We have here present several gentlemen who have made this subject of an interoceanic ship canal a matter of especial study, and their views upon it are necessarily of importance. I will ask Mr. A. G. Menocal, Civil Engineer, who is present, and who is to be in the city but a day or two, to give us his views as to the proper canal to be constructed, and some account, if he will do so, of the Nicaragua route, of which he made the survey.

Responding, Mr. Menocal opened the discussion of the evening by the following remarks:

It will not be necessary, I suppose, for me to enter into any description of the state of Nicaragua, which doubtless is well known to all here. The Lake of Nicaragua, which is at the summit of the proposed canal by the so-called Nicaragua route, is a body of water 110 miles in length, by 30 miles of average width, having a superficial area of 2,700 square miles. Its elevation above the sea at high tide is 103 feet, and at mean tide 107 feet. The depth, from a point 1,200 feet east of its west side to within about nine miles of its outlet, the San Juan river, is at all points as much as 30 feet, and in some places as much as 150 feet. Several lines were run from the lake to the Pacific ocean to find the lowest depressions in the supervening mountains, and two were found that seemed to offer the best prospects; in one of these the point of greatest elevation above the level of the lake was 43 feet, and on the other it was 134 feet. The length of the former is 18½ miles, of the latter 16⅓ miles. The latter, the shortest, was recommended, for the reason that though the summit was higher, there is on the other line a small stream, or river, carrying 5,000 cubic feet of water per second, that would have to be received into the canal. The level of the lake is to be extended westward eight miles to the slope down to the Pacific. From that point to the sea the ground falls at the rate of nine feet to the mile. The locks are to be so disposed that there will be no less than 2,500 feet between any two of them. A ten-foot lift was adopted, not because the foundations were not firm enough to give a larger, but because this was found about the mean lift of all the locks then in operation in the United States, and was deemed sufficient. Possibly, on the final location of the line, a larger lift might be adopted, and the number of locks reduced. This total lift of 103 feet will be overcome by ten locks. There will also be a tide-lock, to overcome the tide of the Pacific, which at the maximum is 8½ feet, with the medium 5½ feet. The level of the canal there is such that vessels can come in at any time from that side without double lockage. That is, we do not need to have a second system of locks, as would have to be adopted in a canal opening from the east at a lower level than that of the sea. The exploration of this line was extremely careful. In some places elevations were taken every 25 feet, and borings were made every 1,000 feet, particularly on the sites of the locks, to ascertain what foundation we could depend on for the construction of the locks. All the small streams that would cross the line of the canal are to be provided for by culverts, through which their water would be discharged into the Rio Grande, the stream running through the gap along the line of which the canal was located; and so perfect is the system of drainage afforded by that river, that the water from any part of the canal can be turned into it, and the desired lock be left perfectly dry. The proposed width of the canal is generally 72 feet, and the slopes of rock are ¼ to 1 above the surface, and ½ to 1 below the surface. In earth, the slopes are 1½ to 1. I have merely given this general description upon such points as have suggested themselves to me, and will be glad to answer any questions that any of the gentlemen present may desire to ask me, before we proceed to the description of the canal on the other side of the lake.

Q. by Mr. GARDNER: What is proposed as the actual width of that part of the canal, surface and bottom?

Mr. MENOCAL: The width varies. In this deep cutting of rock it will be 60 feet at the bottom, 90 feet wide 10 feet above the bottom, and 106 feet wide at the surface. In earth, the bottom width will be 72 feet, and the surface 150.

Q. Is there any tunnel from the lake?

Mr. MENOCAL: No, sir; the elevations are not sufficient between the lake and the ocean to require a tunnel, being only 43 feet on one line, and 134 feet on the other.

Q. The depth of the water, I presume, is 24 feet?

Mr. MENOCAL: No; 26 feet in depth on the whole line of the canal. On the west side, where the canal will leave the lake, there will be an excavation, under water, for 1,200 feet, commencing with zero, and extending into the lock at that depth of 26 feet. That will be as far as we have been able to learn from the indications in gravel and rock.

Q. What is the nature of the rock?

Mr. MENOCAL: Trap rock, the same as we find all along the line; basalt and greenstone. That is, it is the rock generally found, though in some places there is limestone. There is a large bed of limestone at this point, La Flor, between the summit and the Pacific.

Q. Will any of the mountain streams be taken into the canal?

Mr. MENOCAL: No; it is not proposed that any of those streams shall be taken into the canal, but that it shall be fed exclusively from the lake. For that reason the higher elevation was adopted, on account of the better drainage. It is, however, proposed now to make further examinations toward ascertaining the possibility of diverting the Rio Grande into the lake; in which case, the line of the lowest elevation will be recommended as the best for the construction of the canal, as it would save no less than six millions of dollars in the estimates.

Q. Where do you get water for your summit level on that line?

Mr. MENOCAL: From the lake. Its level is extended clear to the slope down to the Pacific. It is the summit, and there is no doubt about the supply of water being ample. In the stated area of the lake is, of course, comprised the area of the other and smaller lake, Managua. The present connection between them is only open when they are full, and the water from this lake does not at all times flow into Lake Nicaragua, but that is a matter easily remedied, and the area of the water-shed properly embraces the water-shed of that lake.

Q. by Gen. GILLMORE: What is the greatest rise and fall of that lake?

Mr. MENOCAL: Four and a half feet seemed to be the maximum. We examined well the water-marks, and from all the indications they afforded, we arrived at the conclusion that that was the maximum.

Q. What is the annual rain-fall there?

Mr. MENOCAL: It varies from 45 to 50 inches. For six months we have hardly a drop of rain. In the rainy season we have frequent showers at night, rains occasionally in the day-time, and sometimes there are rain-storms that last two or three days.

Q. What is the size of the locks you contemplate?

Mr. MENOCAL: The locks proposed are 400 feet long, by 70 feet wide; but that length may be increased to 450 or 500 feet if it is deemed desirable. There are, however, few vessels now afloat that will require above 400 feet, and I suppose that will answer for all practical purposes.

Q. Are there many mountain torrents to bring in debris?

Mr. MENOCAL: No, sir.; not into the canal, which is kept entirely free from surface drainage.

Q. What kind of a harbor have you at Brito?

Mr. MENOCAL: A very small and insufficient one. We will have to build a harbor there.

If there are no more questions to be asked about this portion of the work, I will now pass on to the consideration of that part of the canal on the other side of the lake. The San Juan river is the outlet of Lake Nicaragua, and carries off, when the lake is full, from 12,000 to 15,000 cubic feet of water per second. The river falls but two feet in 28 miles, and then 12 feet in the following nine. There are two rivers emptying into the lake—Rio Rama and Rio Frio—almost parallel with the San Juan, but running in the opposite direction, both of which are large streams.

You will perceive that the water-shed of the river, between the lake and where we leave it, is very small. The depth of the stream will have to be increased, by dredging and blasting under water, to a mean of six feet. The maximum will be at Toro rapids. The fall of the river to those rapids is two feet only, and at the rapids we have a fall of six feet from there to Castillo, where we propose to build the first dam. This dam is proposed to be 940 feet long. The rise of the water will be 18.87 feet in front, and 13.32 below, by the second dam. The second dam will be 1,196 feet in length, and 31 feet high above the bottom of the river. The rise of the water here will be 22 feet above and 12 feet below. The third dam will be 824 feet in length, and 33 feet, or nearly 34 feet above the bottom ; the rise in front 26 feet, and below 16 feet. The last dam will be 1,000 feet in length, and the water will be raised in front 30 feet, the fall 23 feet. In the other dams, the fall will be equal to the lock in the short canal that is going to be built around the dam, which in every case is ten feet and a fraction—ten feet and nearly ten inches. Below Toro rapids, there will be no dredging of the river, because the present depth of the river, increased as it will be by the raising of the water by the dams, will be sufficient, except in two places, to give the required 26 feet. Between the last two dams the river is very deep, as much as 80 feet, which would bring the bottom 30 feet below the level of the ocean.

At this point the Rio San Carlos comes into the San Juan. This is a silt-bearing river, a torrential river, and for that reason the canal is there taken from the line of the San Juan and is built inland. Owing to this high hill right opposite the mouth of the Rio San Carlos, it is proposed to extend the slack-water navigation to a few hundred feet below the mouth of that river, where the last dam will be constructed, and a new channel is proposed for the Rio San Carlos, to divert it and make it empty into the Rio San Juan below the dam, so as to preserve for the canal only the clear water from the lake.

These short canals around the dams are to be about a mile in length ; one is to be three-quarters of a mile, and the others between that and a mile and a quarter. The dimensions of these sections, or small canals, are to be similar to those of the one proposed on the other side of the lake. Now we come to the consideration of the section between where the canal leaves the river and Greytown.

Q. by Gen. GILLMORE : What is the extreme length of this slack-water navigation?

Mr. MENOCAL : Sixty-three miles, with four dams.

Q. by Mr. GARDNER: How far from the lake to the first dam ?

Mr. MENOCAL : Thirty-seven miles; so that really the level of the lake will extend on the Pacific side eight miles to the slope, and 37 miles on this side.

Q. What is the discharge of the San Juan ?

Mr. MENOCAL : It varies. Above this point (indicating on the map) at a high rate from 12,000 to 15,000 cubic feet per second ; below this point, sometimes 22,000 to 24,000, because the volume is increased by this large river, the San Carlos, and others. Besides the San Carlos, as you will see, we have three other rivers coming into the San Juan, below where the canal leaves it. The larger tributaries all come from the Costa Rica side. The largest are the San Carlos and the Serapiqui.

Q. Then from where you enter the lake on the west side there is unimpeded navigation for 93 miles ?

Mr. MENOCAL : Fifty-six and a half, lake—37, river—all at the same level—and eight on the other side ; so that really the navigation is uninterrupted for 102 miles of summit level, 103 feet above high tide.

Q. What is the extreme rise and fall of the slack water of the San Juan in times of flood and drought ?

Mr. MENOCAL : The maximum rise is between four and a half and five feet. The lake acts as a large distributing reservoir, so that the floods have little effect on the rise and fall of the river.

Q. What is the average breadth of the river ?

Mr. MENOCAL : At the broadest point, between the last two dams, it may be, in some places, only about 600 feet. That is where it has such very great depth. Above the third dam there is an average of 1,200 feet, except in one place, where it contracts to 840 feet. That is at Machuca. Above that it is all from 1,200 to 1,500 feet wide.

Q. What is the depth, or what will be the depth, when the improvements are completed?

Mr. Menocal: 26 feet.

Q. And the width at bottom?

Mr. Menocal: 80 feet, with slopes of 6 to 1 where dredging is required. For a vessel drawing 20 feet the channel width there would be 152 feet, and for one drawing 24 feet would be 104 feet. I do not see, really, why the width of this canal should be any larger than the one on the other side, because there are no winds to be feared, because the river is protected by the high hills and forests on the sides, and the current is not over half a mile per hour. The prevailing breezes are from the northeast. Here, in the lower canal, where the line of the dredging to the dimensions indicated extends, the mountains and forests so shield a vessel that there is but a very light breeze. It is so also on the river, and there is no fear of winds throwing the ship from one side to the other of the canal.

Q. What water will you have on the dams?

Mr. Menocal: I have computed very closely the water at the top of the dams at both high and low water. The thickness of the volume of water on the first dam will be 2.93 feet, on the second 2.56 feet, on the third 3.28 feet, and on the last 2.92 feet. The velocity of the water in the river will be, in the first section, .46; in the second and third, .54; and in the fourth, .49; so in only two sections will the velocity of the current be a fraction over half a mile per hour. The flow of the river is, in the first three dams, as near as we could come to it, 12,453 cubic feet per second in the first, and 12,953 cubic feet per second in the second and third; while in the fourth it is 13,206 cubic feet per second. So the difference in the volume between the first and last reach of the canal in that slack-water navigation will be only about 800 cubic feet per second, which is caused by the small streams coming in between the lake and the Rio San Carlos.

Q. Is that at low or at high water?

Mr. Menocal: At low water—I have it also for high water, but fail to find it in the notes I have with me. But I know positively, without having the data to confirm my memory, that at no time will the water on the top of the dam be over four feet in thickness at high water. As you see, it is only the last dam that will have to stand the pressure of the water raised in front. Borings were made at the sides of the river where the locks are to be located, and the character of the rock was found to be the same as on the other side of the lake—that is, wherever rock was found; but we saw very little rock on this side of the lake, only in the bottom of the stream, in reefs, here and there, and in the rapids already spoken of. Here, in the rapids, we did not take any borings in the bottom of the river, but when the lead struck hard bottom we estimated it rock, and where it went through soft material we estimated earth or clay.

Q. What harbor is there on the Atlantic side?

Mr. MENOCAL: There is no harbor. One will have to be made. I am coming to that directly. We are now arrived at the section between where the canal leaves the river and Greytown. It follows the line of the river to this point, as you see on this map, a distance of 24 miles, and thence goes by almost a straight line to Greytown. The line was at first laid out here, along and over these hills, but afterwards I made a complete survey of that part of the country and found a lower path, by which the line can be located at a reduction on the former estimates for cutting, of from one and a half to two millions dollars.

Q. What is the estimated total cost of the work?

Mr. MENOCAL: Fifty-two millions, to which is to be added the customary allowance of 25 per cent. for contingencies—call it, altogether, including the harbor improvements necessary, $65,000,000. The harbor at Brito will cost $2,337,000; that at Greytown, $2,822,000. The cost of harbor improvements, such as will be here required, will be not great, for the reason that we will have abundance of rough stone, convenient of access, from the excavation of the canal, and plenty of excellent wood near at hand.

Q. What is the rise of the tide on the Atlantic side?

Mr. MENOCAL: One and a half feet.

Q. What drainage have you on this side?

Mr. MENOCAL: It varies, but is always amply sufficient (because the river is), though constantly following the canal, at varying distances from it. The bottom of the canal is, however, generally, above the bottom of the river, and the streams coming from the north it is proposed to pass under the canal by means of siphons, except some very small ones that may be received into the canal.

Q. What is your project for the harbor on the Atlantic?

Mr. Menocal: We propose to build a jetty. At Greytown the sea strikes the sand beach at an angle of about 45 degrees, and is constantly shifting the sand from east to west. This has caused the formation of the sand bar now closing the harbor. It is proposed to build a jetty out to a depth of 30 feet at low tide, and let these drifting sands from the northeast accumulate in the angle between the coast and the jetty. In course of time it will fill up there, but then, by a further extension of the jetty two or three hundred feet, we would increase to almost double the area of deposit, and the harbor would be preserved from the shifting sands for a certain number of years. The artificial beach thus formed by the accumulation of the sand may be so shaped that it will be either perpendicular to the prevailing winds, or so inclined to them that the sand, instead of moving toward the entrance of the harbor, will be shifted to the south toward the Colorado, when the harbor may be considered permanently restored. The Colorado river takes $\frac{29}{30}$ths of the water of the Rio San Juan, only $\frac{1}{30}$th going to the harbor of Greytown. It is proposed in the plan for the improvement of the harbor so to obstruct the channel of the lower San Juan, by means of trees and other obstructions, as to throw all the silt-bearing water of the San Juan into the Colorado, and receive into the harbor only the clean water of the canal, drawn from Lake Nicaragua. I have here plans showing the alterations in the harbor of Greytown from 1809 to the present time, and, if you will look at them, you will see at once that the bar has been formed in the way I have described.

Q. Is the mouth of the San Juan river permanent in its location, or has it moved?

Mr. Menocal: Well, it is permanent now, so far as its emptying into the lagoon is concerned. It does not empty into the ocean, but into the lagoon. In the wet season, when the accumulated waters bank up in the lagoon, then it cuts an outlet through the sand-bank to the sea, but as soon as that pressure is removed that outlet is quickly closed again by the sands drifted by the action of the wind.

Q. What is your estimate for the removal of earth from the canal per cubic yard?

Mr. Menocal: Thirty-five and forty cents per cubic yard.

Q. And how much for rock?

Mr. Menocal: $1.25 and $1.50, and under water $5. The blasting and dredging of rock under water will be done in the Rio San Juan before the water is raised by the dams. I think, however, that if it be desired, the dams can be built at the same time the dredging and blasting is going on, by leaving sluices sufficiently large to carry the volume of the river. After all the dams are completed, these sluices—which will be provided with gates—can be closed at once, and then, as the water has to be banked up to the lake, I calculate that it will take about four months before the water comes to the top of the first dam. During that time the sluices and openings will be closed with masonry, and, before the full pressure comes upon them, will have ample time to settle.

Q. What is the material you will employ in the locks and dams?

Mr. MENOCAL: Concrete. It is difficult in that country to find dimension stone. The country rock will make a nice material for concrete work, but it would not do for cutting into dimension stone.

Q. What is the lowest temperature there in winter?

Mr. MENOCAL: About 71°, and in summer it rises to 81°. The variation is only about ten degrees in the year.

Q. Have you examined the old structures on the Isthmus, between the lake and the Pacific, to see if they are cracked by earthquakes?

Mr. MENOCAL: Yes; and they are not at all affected from that cause. They cannot have been injured and repaired, for they are entirely neglected by the Indians; yet they are in as good condition as they were, presumably, when the Spaniards left them.

Q. Do you anticipate any danger to the locks of the canal from the action of earthquakes?

Mr. MENOCAL: Decidedly, I do not. I do not know that earthquakes there ever do any damage to life or property, or that they ever have the slightest effect of altering the water supply in rivers, lakes or wells. But even if the wall of a lock should be cracked, it will be a very simple thing, and readily executed, to repair it.

Q. Are there, properly, less apprehensions of danger from earthquakes there than in other parts of the Isthmus?

Mr. MENOCAL: Not less than in all other parts, but much less than in some others. For instance, in San Salvador they are much more violent and frequent, and in Guatemala and in parts of the United States of Colombia.

Q. Have you examined the ruins left by Walker at Grenada, to note their condition, as to whether they had been affected by earthquakes or not?

Mr. Menocal: I have. They stand to-day just as he left them; those, at least, which were allowed to remain as ruins. The houses were rebuilt, but the churches were not, and their bare blackened walls, standing alone and devoid of any support or braces, rise to a height of, I should say, forty feet. I have examined them very carefully, and did not find a crack in them. Some of the towers were partially blown down then by powder, and look as if they were likely to tumble down at any moment. One, especially, seems threatening to fall with the wind. Yet they stand there as they have stood since 1854. Those are forty-two miles from the line of our proposed canal. In the town of Rivas—two and a half miles from the canal—they have many stone houses, and about ten years ago they completed a stone church there, which had been building during thirty or forty years—one which would be a noteworthy stone church anywhere—and it has never received any injury from earthquake shocks, nor have the stone houses about it.

Q. Those Spanish ruins at Grenada, Castillo and San Carlos must be over one hundred years old?

Mr. Menocal: Not less than three hundred years, probably, some of them. I had occasion to show to the United States commissioners dams that had been built surely over one hundred years ago, which are standing to-day, though not for any present practical purpose, which have never been repaired, yet which manifest no imperfections which can be detected by the closest examination. They were built originally for the purpose of damming up water to be used in the manufacture of indigo, and were abandoned, and have been standing there for one hundred years, perhaps. We saw a gentleman who lived close to the dam near Rivas, and he said it had been there since he was born—he was not less than seventy years old—and before his time, but he could not say how long, as his father never told him when it was built. Yet it is now in the same perfect condition that it was, presumably, when first built, with no cracking, no imperfections and no leakage. Yet it has no apron, and the water has a sheer fall of 15 or 20 feet to its base. Its length is 75 feet. That shows, to my mind, not only that earthquakes there will do no injury to constructions of this character—the locks of our canal, for instance—but that the material we have there for the construction of the work is of the best quality.

Q. What material did you say you proposed to use for locks?

Mr. Menocal: Concrete; and I suppose the lime of the country would be sufficient.

Q. What sort of wood have you?

Mr. Menocal: Oh, excellent—of various kinds, with Spanish names that I do not recall at this moment.

Q. Are those old Spanish works of concrete?

Mr. Menocal: Rubble masonry, with mortar between; the spaces among the large rough stones filled in with smaller ones and mortar.

Q. by Gen. Gillmore: At what do you estimate the cost, per cubic yard, of this construction?

Mr. Menocal: From $7.50 to $9 per cubic yard for the locks, and $12 per cubic yard for the dams, on an average. To be explicit, take lock No. 2 as an example: concrete and foundation, $7; lock walls, $8; lift walls, $8; rubble masonry, $7.50 per cubic yard. For the dams across the San Juan the estimates are: rock excavation, $5; hydraulic concrete, $12; rubble masonry, $15; concreting abutments, $8; coping (dressed stone), $20, per cubic yard.

Q. You can get all the materials there at hand?

Mr. Menocal: All the materials. The excavations of the canal will furnish the stone, and the lime of the country will answer every purpose. They have built a small water-works at Masaya, in Nicaragua, which lifts the water 224 feet; and they have constructed a reservoir or tank in the centre of the town, where they store the water to a depth of 20 feet. The thickness of the wall of this tank at the bottom is only 4½ feet, hardly the theoretical thickness required for the best possible construction of such a wall, yet this is built only in the roughest way, of rubble work, and though it has been in use four or five years, there is not the slightest sign of any imperfection from weakness, earthquakes or any other cause.

Q. How about the harbor on the Pacific side?

Mr. Menocal: On the Pacific side, we propose to build a jetty here (indicating on the map), starting from this point, 800 feet in length, extending out to 25 feet depth of water; and another jetty here, running westward, to prevent the sand shifting into the harbor. Then the harbor will have to be dredged. No rocks will be encountered there. I have tested to a depth of 30 feet under water and found the bottom all sand. The materials for the jetties will be taken from this hill, on the coast, which is nothing but trap-rock.

After these surveys were completed, the government ordered a commission of two army officers, an assistant to the coast survey, and two civil engineers, to go over the line and verify the work. The line was located only two years before, so that the stakes and bench-marks marking the locks, cross-sections for dams, etc., were still preserved and were carefully examined by them. Also, through our suggestion, several portions of the line were carefully re-surveyed by them to determine the accuracy of the surveys which had been made. All were found to be perfectly accurate in every point. Bench-marks were found about every 2,000 feet along the line, and the profiles were found to be the actual facts in the careful surveys we had made. After they were made, I was in the country several times, in connection with the improvement of the Rio San Juan and harbor of Greytown, and also with reference to a proposed improvement connecting the two lakes—Nicaragua and Managua. Then I made still further careful surveys of this portion of the line, and I know that modifications of the original survey can be made that will reduce the cost of the canal perhaps ten or fifteen per cent. I am sure that any change made in the line, in accordance with my suggestions, will tend to reduce the estimates.

Q. In what year were the estimates made?

Mr. Menocal: In 1872.

Q. What was Mr. Child's estimate?

Mr. Menocal: His estimate was for a canal only 16 feet in depth, and I think it was $34,000,000. Perhaps it was only seventeen or eighteen millions; I do not remember now.

Q. What is the radius of your shortest curves?

Mr. Menocal: 2,200 feet. That is the minimum adopted, and was recommended by naval officers whom I consulted on the subject. They said that the versine of an arc with a chord of 500 feet in such a curve being only 4 feet, there would be no difficulty in taking a ship 400 feet in length around a curve of that radius. An enlargement of the radii of all curves to 5,000 feet would not increase the estimates more than one and a half or two millions of dollars.

Q. Did you see any external indications of earthquakes along the line of the canal?

Mr. MENOCAL: None whatever, sir; and I would like to call upon Mr. Ford, an expert engineer who is conversant with that country, to say what is his information upon this subject of earthquakes.

Mr. A. L. FORD: It is commonly said there, and reported in the authorized government history of the country, that there has been no instance of loss of life or property by earthquakes.

Q. by Mr. MENOCAL: You went through Leon?

Mr. FORD: Yes; and I saw no marks or imperfections caused by earthquakes. I also examined with interest some very large concrete-walled tanks—indigo vats—that have been built several hundred years, but show no signs of cracking.

Q. by Chief Justice DALY: Does this apply to the whole country?

Mr. FORD: It is so said. I do not know of my own knowledge, as I did not go through the whole country.

Q. by Chief Justice DALY to Mr. MENOCAL: What are the most prominent engineering objections to the Panama route?

Mr. MENOCAL: I suppose the Chagres river offers the most really serious one, and the rise and fall of the Pacific tide and the prevailing calms at Panama the next. The Rio Chagres, in the dry season, is a very small stream, say 250 feet wide and two feet deep. I have waded across it many times. But in the rainy season it becomes a torrent and rises in less than a single day to a maximum of 40 feet. In that case the width of the river is some 1,500 feet, and the volume of water carried fully 160,000 cubic feet per second. The bed of the river is 42 feet above the sea, and as it rises 40 feet in flood at the point where it is proposed to be taken into the canal, you see it will have to be received into the canal with a fall of 82 feet, or say 78 feet, making allowance for the decrease due to the velocity of the water as it approached the precipice, and for the head of water above the ocean level after falling.

Q. Does not the Chagres river bring down much debris?

Mr. MENOCAL: Oh, yes; very much—decayed vegetation, mud, trunks of trees, houses even. In the recent floods it carried away two whole villages. I see reports that it even carried away an iron tank that was 17 feet above the level of the Panama railroad track.

Q. What is the rock formation there—on that route?

Mr. MENOCAL: Sandstone, conglomerate, limestone, coral, and in the upper Chagres large masses of a very soft limestone, so soft that with a half-pound hammer you could break off large pieces of it. And it is not a continuous mass. On one side of the river you will see a vertical, or even overhanging, limestone wall, 80 feet high, and on the other side of the river four or five feet only of limestone, with 20 feet of clay on the top of it; and in a few feet farther you will find the limestone wall on the other side of the river where the clay was, and the clay on the side where the limestone was.

Q. How does M. de Lesseps propose to deal with it?

Mr. Menocal: At the Paris Congress they proposed to build an artificial channel from where they intend to take the river-bed for the canal to the sea.

Q. How far is that?

Mr. Menocal: It is 30 miles by railroad; I do not know how far by their canal. They will have to cut through some very high hills and mountain spurs projecting on both sides of the river to its very banks, in order to straighten its tortuous course to meet the practical requirements of a ship canal; and they will have to build walls across the lower valleys between the high hills extending to the river. As the cross-section of the river is 15,000 square feet, and the water-section they propose to give the canal is about 2,000 square feet, the new channel for the river will have to be no less than 7½ times the proposed section of the canal.

Q. Do you think the enormous waterfall there would have any effect upon a marine railway?

Mr. Menocal: I think it would, as has been proved by the great damage done to the Panama railroad by the recent floods of the Chagres river.

Q. The canal, then, would have to discharge 160,000 cubic feet of water per second in time of flood?

Mr. Menocal: Of course, since it is to receive the volume of the river; and what difficulties may have to be encountered in confining so great a body of water, moving with such velocity, in an artificial channel, we may well appreciate, since we all know how hard it is to divert even small streams and confine them to new channels.

Q. And the velocity is very great?

Mr. Menocal: No less than seven miles per hour with the present fall of the river, and as the canal is only a few hundred feet from the river, and the water of the river is several feet above that in the canal, we may well fear that at any time the river may overflow its artificial banks and flood the canal.

Q. by Chief Justice DALY: Will you not explain a little more fully the difficulties to be encountered at the mouth of the canal—I mean of the Panama route—and the means by which the projectors of that route propose to overcome them?

Mr. MENOCAL: I do not know what plans they propose to adopt.

Q. You suggested a difficulty from the character of the coast?

Mr. MENOCAL: If they build their canal at the level of the sea at Panama, they will have to excavate in the Bay of Panama one and a half miles under water, and in the harbor of Colon they must also excavate under water a long distance to get sufficient depth for their canal.

Q. And they will require steam vessels to get sailing vessels out of the Bay of Panama, will they not?

Mr. MENOCAL: In regard to that, I will request Col. Myers to read a paper I have here—a letter from Commodore Maury—with some remarks thereupon by Captain Pim, of the Royal Navy.

Col. T. BAILEY MYERS read the following:

"30 HARLEY ST., CAVENDISH SQUARE,
"LONDON, July, 1866.

"MY DEAR CAPTAIN PIM,—I had occasion some years ago to study, more or less closely, almost every route between the British possessions on the north, and the Isthmus of Darien on the south, whether rail or canal, that had up to that time been attempted or projected across the American continent. Owing to the character of the researches with which I have been for more than twenty years engaged, my attention was directed to those routes rather in their physical and commercial aspects, than to their topographical features, or to their facilities of construction.

"The great importance of one or more *good* commercial highways across Central America being admitted, the whole question as to route resolves itself pretty much into a question of the cost of construction, and the facility of ingress and egress by sea to and from the opposite termini; the latter is an affair of winds and currents. Their influence is powerful. Panama has the advantage of land transit; Nicaragua has the advantage in winds, terminal ports and climate. The first is obvious; but to place the latter in a clear light, a little explanation may be necessary. * * * I have spoken of a calm-belt about the equator; Panama is within its range. Owing to the contour of the Central American isthmus, the height and direction of the mountain ranges by which it is traversed, and the influence of these upon winds, this calm-belt is greatly enlarged on the Pacific or lee side of the isthmus. It is difficult to convey, to one who has never experienced these calms, an idea of the obstinacy with which they vex navigation. We are all familiar with calms at sea, which last for a few hours, or even a day; but here they last for days and weeks at a time. I have known vessels going to or from Panama to be detained by them for months at a time. * * * On one occasion the British Admiralty, wishing to send one of their sailing vessels into the Arctic ocean from Panama in time to save the season, had her towed by a steamer through this calm-belt, and carried 700 miles out to sea before she could find a breeze. * * * These remarks apply to the approach and departure by sea to or from the Pacific terminus of any route across the Isthmus of Panama or Darien, and even with greater force to the Atrato and others on the South American side of Panama. In short, the results of my investigation into the winds and currents of the sea, and their influence upon the routes of commerce, authorize the opinion which I have expressed before, and which I here repeat, namely: if nature, by one of her convulsions, should rend the continent of America in twain, and make a channel across the Isthmus of Panama or Darien, as deep, and as wide, and as free as the Straits of Dover, it would never become a commercial thoroughfare for sailing vessels, saving the outward bound, and those that could reach it with leading winds. Steamers would and coasters might use it, but homeward-bound vessels in the China, India or Australia trade rarely. * * * We come now to the Nicaragua routes. Of these there are several. Though longer across from ocean to ocean than Panama, some of them have already, and with a degree of success by no means discouraging, competed with it before the world for public favors. * * * Skillful engineers, both French and American, have examined them [the engineering difficulties and topographical features of this Nicaragua route]. Those of both nations report gradients gentle enough for a canal. In truth, the lakes, their distance from the sea, and their height above it, indicate that the summit-level is to be attained without any very steep ascents.

" It is to this part of the isthmus, too, to which we must look for a route which shall best fullfil the present requirements of commerce between the two oceans, as well as for transportation and travel between the Pacific shores of North America on the one hand, and the Atlantic shores both of Europe and America on the other. * * * Vessels under canvas would, in the main, do the fetching and carrying for the Nicaragua route, which, for reasons already stated, cannot be done for Panama. The aggregate amount of this trade is immense, and it is neither accommodated for Panama, nor Panama for it. * * * Therefore, returning again to the physical features of the Panama route, as I promised to do, we can now compare more in detail than I have yet done the advantages possessed by each, as far as those advantages are influenced by facilities of navigation, by the elements, by salubrity of climate, and by the dictates of commerce. The French and English Admiralty charts give the most accurate information that I possess concerning the harbors at the opposite ends of the two routes, Panama and Nicaragua—I mean as to mere anchoring ground, depth of water, and shelter afforded. It is proper to remark here, that I was a great friend, an earnest advocate, and an active supporter of the Panama road, giving it in 1849 the preference over all other isthmian routes. At that time my 'wind and current' investigations had not extended into the Pacific ocean, and the discovery of those causes which make the approach and departure to and from the Bay of Panama so very difficult for sailing vessels had not been sufficiently established to give them their proper weight. * * * You will observe, at a glance, that the Isthmus of Panama, or Darien, is, on account of these winds and calms, in a purely commercial point of view, the most out-of-the-way place of any part of the Pacific coast of intertropical America. * * * 'Lieutenant Maury,' remarks Mr. Hull, master of H. M. S. *Havannah*, 'truly says that the passage under canvas from Panama to California is one of the most tedious, uncertain, and vexatious that is known to navigators.' Realejo (Nicaragua) is in the northern verge of these calms (Panama), and where they have nearly ceased to be vexatious to the navigator any season. Here, then, is the physical advantage in favor of the Nicaraguan route, for which it is difficult to find the money value. * * * The transit route of Nicaragua is exempt from those heavy drawbacks of dampness and disease. It passes through a salubrious climate. The soil is productive; its pastures abound in cattle. I never heard of any disease peculiar to the country, or of especial virulence there.

[Signed] "M. F. MAURY."

Col. MYERS: Upon the foregoing letter, Captain Pim goes on to remark, in a paper read by him before the British Association in Sheffield, this year, as follows:

"Commodore Maury tells us in the plainest language, that if nature, by one of her convulsions, should rend the continent of America in twain, and make a channel across the Isthmus of Panama, or Darien, as deep, and as wide, and as free as the Straits of Dover, it would never become a commercial thoroughfare for sailing vessels, and I have only to endorse this opinion; for of all parts of the world I have ever visited the calms in the Bay of Panama are the most vexatious and enduring. It therefore seems the clear duty of a Central American Isthmus canal projector to decidedly avoid this locality. Under these circumstances it becomes necessary to look elsewhere for a more feasible line of transit, and (once more relying upon the letter of Commodore Maury) the route from the Atlantic by way of the magnificent Nicaraguan lakes to the harbor of Realejo, seems that which is adapted for the required purpose; for, as Commodore Maury states, and I quite agree with him, it would be impossible to exaggerate the money value of having, as he describes it, a fair start and approach by means of the little monsoons of that coast.

"Assuming that arrangements can be made for transferring the public favor—or perhaps I ought to say that of M. de Lesseps—from Panama to Nicaragua, I think it may be desirable, as I have been many, many times over that route, to give a general outline of its features, and I will conclude by offering a few suggestions, which I trust may prove of utility to those who will embark in the grand enterprise of effecting a junction between the Atlantic and Pacific oceans. The great difficulty to be overcome in the construction of a canal across Nicaragua is in the making and maintaining the harbor of Greytown on its Atlantic terminus. My friend, the late Mr. Robert Stephenson, the great engineer, when I was with him in Egypt in 1858, used to say that he was acquainted with the deltas of all the great rivers of the world, but that he was not aware of a single instance in which a harbor was maintained at the mouth of such rivers. Now, the Rio San Juan de Nicaragua has a delta at its mouth, but no other delta in the world is so capricious. In 1856 a squadron of Her Majesty's ships rode securely at anchor in the harbor of Greytown; but in 1860, when I was stationed as senior naval officer in that locality, the sand-bar which made the harbor stretched across very nearly from shore to shore, leaving only sufficient depth of water for the very smallest coasting craft. A few years later there was again a considerable opening, and so matters go on, but now for some time it has been completely closed. A strong norther is sufficient to close the harbor, while a high river will reopen an entrance. Mr. Robert Stephenson's dictum, therefore, as to the enormous difficulties to be encountered in the attempt to form a harbor at the delta of any great river is more than borne out in the case of Greytown; although I am well aware that an exception has occurred to this ruling in the case of the Mississippi, where Mr. Eads has succeeded in obtaining a depth of 27 feet, under high pressure from Congress; but the problem is, how to *maintain* that depth at anything like a paying cost? If the engineering difficulties could be overcome in forming and maintaining a harbor at Greytown, the other obstacles to the opening of the canal from ocean to ocean would be found of very secondary importance; but to my mind the cost of such an undertaking would completely paralyze the enterprise."

Q. by Major SIDNEY F. SHELBOURNE: Can you tell me, sir, whether Captain Pim does not now hold a concession for a canal by way of Nicaragua?

Col. MYERS: I cannot, sir. I have simply been requested to read this article, and know nothing farther of Captain Pim's interests in or associations with any interoceanic ship canal enterprise.

Mr. THOS. DE FRANCO: He holds a concession for a railway instead of a canal, I understand.

Major SHELBOURNE: I hold in my hand an article in which it is stated that there are now three concessions for Nicaragua canal routes—one to M. de Belly, one to Captain Pim, and another the one in which Commodore Vanderbilt was once interested.

Col. MYERS: I take it, sir, that it is entirely immaterial to the discussion of the questions at present before us who holds concessions, or is going to furnish the money to build the canal. What we are endeavoring to arrive at is a knowledge of the feasibility of the several routes, their difficulties and advantages, by such information as Mr. Menocal is now endeavoring to give us from his surveys upon the route he advocates. When we have heard from him we hope to hear from others, until we have collected all the information possible of value for the world. It will then be time to discuss other questions. There have been for years, as we are all aware, many projects, in some cases sustained by official grants for various forms of transit, none of which were carried out, perhaps for want of money. The present discussion has again called attention to them. If any of them are an improvement to those accepted by the French Congress, or approved by the American government, the projectors will have the opportunity of settling their relative merits amongst themselves, and with those who appear to be acting with an assurance of means to build, and therefore must have the privilege in the end of selecting their route. Having no interest myself, present or prospective, in any project, I feel at liberty to express this opinion.

Mr. MENOCAL : The reason I asked the reading of the letter and accompanying matter was simply for the purpose of placing before the meeting the opinion of so great an authority as Captain Maury.

Q. by Chief Justice DALY : Do the trade winds blow regularly, on both sides of the isthmus, at the termini of the Nicaragua route?

Mr. MENOCAL : Yes, sir.

Q. And how far down do they extend on the Pacific side?

Mr. MENOCAL : Not so far as Panama. A sailing vessel generally gets about as far as Costa Rica without difficulty.

Q. And with those trade winds, sailing vessels can at all times approach either the Pacific or the Atlantic end of this canal?

Mr. MENOCAL : Yes, sir.

Q. It is published that your estimate for passing a vessel through the canal is thirty-eight hours?

Mr. MENOCAL : Yes, sir ; that is correct.

Q. At what rate of speed would that be?

Mr. MENOCAL : Three miles per hour in the canal, eight in the river and ten in the lake, the usual speed of a steamer at sea. The time allowed for passing through the locks is twenty minutes. There are some gentlemen here who have some experience with canal locks, from whom I would be glad to hear an opinion as to whether this is an over-estimate or not. Mr. Seymour and General Gillmore can speak as authorities on this subject, I believe.

HORATIO SEYMOUR, Jr.: I do not know that I am particularly posted in this matter, any more than are a number of other engineers here.

Mr. MENOCAL: Only in regard to the time required to pass the locks, I should like to hear your opinion.

Mr. SEYMOUR: I should say twenty minutes for each lock was a proper estimate of time. It takes a boat eleven minutes to go through one of the Erie canal locks. At the Sault S'te Marie it takes twenty minutes. Col. Weitzel estimates twenty minutes as quite sufficient.

Gen. GILLMORE: Twenty minutes is an ample allowance of time.

Q. by Chief Justice DALY: I understand these locks are made for 3,000-ton ships. Can you slow up a 3,000-ton ship, get it through the lock and start it again in twenty minutes?

Mr. MENOCAL: That is what more experienced engineers than myself in canal operation believe is practicable.

Q. Are there any locks in the world, of the same magnitude as these are intended to be, which would afford a precedent as to time?

Mr. MENOCAL: Not except in the enlargement of the Welland canal, which at least approximate. They are 270 feet in length, by 70 in width. Here in the United States I think we have locks 400 feet long, but not so wide or so deep. The Ohio locks, I think, are only twelve or fourteen feet in depth. It is in the handling of the ship, where you have to swing it around, that time is required, and that will be all that will cause delay in the operation of the tide lock—getting it into the axis of the lock. But in a canal where the line of the vessel is in the axis of the canal, all we have to do is to stop the velocity of the ship, close the gates, and then, when the gates before her are opened, the ship starts again, promptly, and without any swinging around. The opening and closing of the locks can be done in a very short time.

Mr. GARDNER: There can hardly be greater difficulties in passing ships through ship canals than are encountered in the St. Lawrence canal, yet nine thousand were passed through there in one year.

Mr. Menocal: And they have there but one system of locks, have they not?

Mr. Gardner: I think most of them are single.

Mr. Menocal: The engineer of the North Sea canal, Mr. Conrad, who is in favor of M. de Lessep's plan, told me they could pass seventeen ships during the hours of the day—they do not operate the locks at night—through the two great locks of the North Sea canal; that is, large ships of four or five thousand tons. If there were that number of ships to pass through our canal, with a system of single locks, we could carry four or five times the probable trade of the canal.

Q. I understood from Lieut. Wyse, in a series of interviews I had with him last winter, that M. de Lesseps was opposed to the lock system, because there was no precedent by which to satisfy owners of vessels that they would be safe in entrusting their vessels and cargoes to such an extensive system of lockage as proposed by the Nicaragua route, or by the plan he himself proposed by way of the Atrato.

Mr. Menocal: It is to be remembered that M. de Lesseps is not an engineer, and never had anything to do with canals until he was a financial promoter. I have here the opinions of M. Cotard and M. Lavalle—two prominent French engineers, who took an active part in the construction of the Suez canal. They find no difficulty in building a canal on the plan proposed by the Nicaragua route, and before the Paris Congress advocated the construction of that canal. M. Lavalle has subsequently stated before the French Society of Civil Engineers that the efficiency of the Suez canal would have been increased if a tide lock had been built on the Port Said side of the canal. Neither of those engineers anticipate any difficulties in working a canal with locks, provided they are properly built and sufficiently supplied with water.

Mr. Gardner exhibited a profile of the Welland canal improvement. He said: This represents a canal 27¼ miles long. You will observe that there is a perfect staircase of locks, to carry vessels of 2,000 tons, and the total lockage, by this staircase, is 326¾ feet, or three times as high as from the Atlantic to the summit-level of the proposed Nicaragua canal. These locks are 240 by 40 feet, with a depth of 14 feet. The total height of the lockage between the lake and Montreal, is about 550 feet. The Canadians built their first ship canals in 1829, and after about twenty years' experience with the system, were so well satisfied that they commenced enlarging and improving them, and they have expended about thirty million dollars in this work of enlarging these canals so as to make them practicable for 2,000-ton vessels. The Canadian engineers have more experience than any others with long ship canals, and demonstrate their success most practically by the enterprise with which they are extending and enlarging their serviceability. The total expenditure of Canada on this long ship-canal route, when it shall have been completed, will be over $54,000,000.

Chief Justice DALY: Within $10,000,000, nearly, of the Nicaragua canal's estimated cost.

Mr. GARDNER: Yes, about the same as the Nicaragua canal proper. But here this lockage, in a single place, within a distance of seven miles, is three times as great as that required on the Nicaragua canal. The locks are not as large as it is proposed those shall be, but they are large enough to carry 2,000-ton vessels, and these vessels succeed each other rapidly, one right after another. Through the old Welland canal they could put through 4,400 vessels in a single year, but through the new system 9,000. I telegraphed yesterday to the Secretary of the Department of Railroads and Canals, at Ottawa, to know the actual time a vessel made in going from Port Colborne to Dalhousie, and he sent me back word that he had transmitted full information by mail—which does us no good this evening. I had hoped to be able to present the information now, but will have to defer it until another time.

Q. How many locks are there in that staircase?

Mr. GARDNER: They have 27 in the flight, of about 12 feet lift.

Major SIDNEY F. SHELBOURNE: It is disagreeable to have to differ from a gentleman of such experience and ability as Mr. Menocal, but I shall have to say something regarding the calms in the Bay of Panama. I am not in favor of M. de Lesseps's route. I think it impracticable, financially and scientifically. I am in favor, however, of the San Blas route, which opens into the Bay of Panama, and I have taken particular pains to investigate that matter of the calms in the Bay of Panama, because I have heard it reiterated, again and again, what difficulty vessels would have in passing into and out of that bay. It is true there is a belt of calms, extending from about 4° north latitude to 14° or 15° north latitude, and it extends all the way across the Pacific ocean to the China seas. It varies in its width, sometimes extending not higher up than 8° or 10°, sometimes to 14° or 15° north latitude. Within this larger limit is the Pacific terminus of the proposed Nicaraguan canal. The San Blas terminus is in about 8° north latitude. This belt is called by sailors "the doldrums," and is not wholly calms, but full of variable, shifting, light winds and calms. I have taken the opinion of sea captains in the California trade—have gone on their ships and enquired about it—and I have consulted with Mr. Charles Frederick Elwell, President of the Maritime Association of this port, and head of a very old shipping firm that sent out the first supply vessel to California. He said that in a single year his firm had sent as many as 125 to 130 sailing vessels to Panama and Aspinwall, and "they would just as lief go to Panama as to any other port on the coast; there was no difference." Maintaining the view I had fixed in my mind that there was in the Bay of Panama, during about one third of the year, a season of almost perpetual calm, I asked him if there was not a time when there were nearly constant calms in the Bay of Panama, but he wouldn't hear to that. Now Mr. Elwell has no interest in this matter, and he said that his firm "would as lief send vessels into the Bay of Panama as any other port on the coast."

But now, suppose the argument was true, that there were calms in the Bay of Panama, and that the fact was due to that bay being in the belt of calms or equatorial "doldrums," would it not then be apparent to you that, if this belt extends across the Pacific, then vessels passing through the Nicaraguan canal, and coming out near the northern verge of that belt, if bound for any South American Pacific port, Japan, China, or Australia, would have to pass through this belt of calms—through the whole of it? But vessels going through by the San Blas, or Panama route, would only have to pass through one-half of it, admitting the full extent of their argument.

Captain Pim and Lieutenant Maury doubtless stated this as a matter of scientific inquiry, but those men whom I have consulted have realized it, experienced it in their business as a fact, and are, surely, competent to judge of its importance. Now is book knowledge, or scientific experiment and knowledge, to be compared with the practical experience of sea captains and shipping houses who have carried and sent vessels by the hundred into this very port? Which is worth more, the opinion of one party or of the other? With regard to this Nicaragua route, the subject is so large, the figures so extensive, the plans so elaborate, that if a person has not studied them by days and weeks a very plausible and fair-seeming statement of the different parts of the plans would pass muster, and be accepted almost anywhere, even with an audience as intelligent, and capable of judging of things, as this audience is. But let us look at them a little. You will see, from Mr. Menocal's statement of the width of the bottom of his canal, in rock, that it is 60 feet; the slope of the wall one vertical to one horizontal. That is, at four feet from the bottom you will have a width of 64 feet.

Mr. MENOCAL: Excuse me a moment. Sixty feet is the width of the bottom of the canal at a depth of 26 feet; at a depth of 16 feet the width is 90 feet, and on the surface of the canal it is 106 feet. But it will be observed, by looking at the section of the water-prism of the canal, that by continuing the slopes proposed of $\frac{1}{2}$ to 1, from the surface of the water to the bottom of the canal, the bottom width will be 72 feet, or more than the Suez canal, and the increase in the excavations will be insignificant, probably not more than 500 cubic yards in the whole extent of rock excavation in the canal.

Major SHELBOURNE: Even allowing that change to have been calculated in the plans and made, the canal 72 feet wide upon the bottom, with this rise of one foot vertical to one-half foot horizontal, would still, at a height of four feet from the bottom, be but 76 feet wide. But vessels of three, four, and five thousand tons, such ships as would be employed in this interoceanic trade, have a beam of 40 or 45 feet. Now two vessels of that size, each drawing 24 or 25 feet of water, could not meet and pass in that section of the canal, because the outer side of each would graze upon the unexcavated rock. The canal is not wide enough on the bottom in the rock section, and any just estimate of its cost should be based upon a very material enlargement in this direction. Another thing that materially affects the estimates is, that while the canal is calculated on a depth of 26 feet on this route, the calculations for the San Blas and M. de Lesseps's routes are made upon the basis of a depth of 28 feet. Between the lake and the first dam, Mr. Menocal says, is 29 or 30 miles, and the excavation would be made to an average depth of six feet. Now, then, in that part of the river we have, according to Mr. Menocal's own estimate, some 834,000 and odd cubic yards of rock excavation required to get the depth of 26 feet of water. Then you have a width of 80 feet to obtain; and, understand, that excavation in the rock is not all at one point, but at various places along a distance of some 28 miles, in removing reefs of rock spread out in the river, in some instances only a little to come off, in others more. He says that excavation can be made before the dams are completed—that is, he would have that rock excavation to do under a depth of, say, 10 to 15 feet of water, and that water the current of a river, before a dam is built upon it. My experience shows me that it would be easier to blast out and remove rock from a depth of 26 feet in still water, than under 10 or 14 feet where you have a current of three or four miles an hour, or even less, to contend with. But, granting him the most favorable conditions in still water, Mr. Menocal has put his estimate for this rock excavation much too low. He has placed it at $5 per cubic yard. Now we all know that here in New York harbor, where there is competition and the best appliances, for simply lifting rock from the bottom, and taking it away after it has been blasted out by Gen. Newton, in his work in the East river—and that not in Hell Gate, but from other obstructions he has been removing—the cost has been something like $4.50 per cubic yard. The latest estimate, I believe, was $2.26 per ton, and two tons are calculated to the cubic yard. That would make a difference in Mr. Menocal's estimate of $6,424,245, taking the quantities of necessary excavation he has calculated upon. If you should go to 28 feet in depth, to put figures on a comparison with those of other routes, as all submarine reefs increase in contents more or less largely as they go down, you would have a still greater quantity, an indefinite but vast quantity, to add to the present estimates. Suffice it to say, taking the 10,000 and odd cubic yards of rock excavation at the west side of the lake where the canal passes down to the Pacific, and adding the number of cubic yards in the river where the slack-water navigation is to be, the whole quantity would be 856,566 cubic yards. In this paper he has undertaken to justify the figures he has placed, by saying that Col. Child's estimate in 1851 was from $2.50 to $5 per cubic yard. He has also estimated the gravel and sand dredging in the river, at a depth of 9 to 14 feet, at 2,180,589 cubic yards. Now, if you will look on the map, you will see the curves and angles of that river, and I should like to ask any engineer, who has practically excavated such a work, whether a width of 80 feet, following the course of such a crooked river, would be wide enough to allow vessels to pass without grazing their sides and bottoms on the rocky sides of that tortuous cut. Again, in regard to the open cut. He has made the sum of that 14,677,389 cubic yards, and he has told you that he has estimated the cost of that at $1 to $1.25 per cubic yard. Now, all engineers who have done any work on the isthmus—among them Col. Totten, Mr. Evans and other gentlemen of practical experience—will say to you that that price is wholly inadequate for that work. In some particular localities it might be sufficient, but not here. To bring the figures up on the basis of the estimates on the other routes would add to that estimate for that open-cut work the sum of $24,535,469, making those two items—the six million dollars necessary increase on the item of rock excavation in the river and these twenty-four millions—something over $31,000,000. Adding that—with the customary percentage for contingencies—to their present estimate, would bring the total cost up to $104,421,790. Moreover, on the canal on the Atlantic end, there is a stretch of seven miles that will have to be constructed through a swamp imbedded with trunks of trees—a perfect network of trees, and stumps, and other material. The removal of this is not so difficult as the fact of maintaining a canal through such a swamp, with such a section as Mr. Menocal has estimated for it. A slope of 1½ to 1 is wholly inadequate. In such a swamp, where it is more or less mud, the material taken out in the excavation of that canal would have to be put far back on the bank. Now, then, to increase the estimate for that part of the canal—those seven miles through the swamp—necessarily to increase it to obtain a work capable of being maintained, to make the slope 4 to 1 and get a width of 100 feet on the bottom, would add some 9,000,000 of cubic yards (double what he has allowed) to the excavation. And when you have done that you will still have to line those walls with rip-rap to get them to stand, besides putting the material taken from the cut far back from it, to prevent its weight and slipperiness pushing it back into the canal. This part of the canal passes through two or three small lakes, and there is a river called the San Juanillo that crosses it almost at right angles. What provision has been made for that river I do not know, and cannot find out from the estimates.

Again, in the lake, there are seven miles, from Fort San Carlos on the east side out into the lake seven miles, where the excavation of the mud has to be to a depth of 10 feet on an average. Mr. Menocal has said that the width of the bottom there was calculated to be 80 feet, with a slope of 4 to 1, and he thought, because vessels would not meet with any wind in that part of the canal, that that bottom was wide enough. Now, in all government works, it has been calculated that a channel, where the excavation is only 3 to 6 feet upon an average, and it is desired to make it navigable for large ships, should have a width of 300 feet at least. I will refer you, by way of illustration of such a work, to the channel which is excavating in the Patapsco river for the improvement of Baltimore harbor, under the direction of Col. Craighill. They commenced that with a width of 500 feet, and have been increasing it.

Mr. Menocal says sailing vessels would probably be able to sail across the lake and not be obliged to take a tow. But this evening he states that that channel would be wide enough because there would not be any wind there. How then could sailing vessels go across the lake without any wind? They would have to be towed across the lake. But, to increase the width of that channel to a width of 300 feet and provide as would be necessary in such soft material, you would have to excavate 12 feet, with a slope of 3 or 4 to 1. A friend who has sailed across that lake tells me that the paddles of light-draft side-wheel vessels would blacken the water by stirring up the mud from the bottom, it was so soft. So, to maintain that cut there, you would have to be continually dredging to keep it 300 feet wide, and you would have to buoy it to make it convenient or safe even for steamers. As regards the harbors on both sides you have had sufficient information, and are able to judge of the difficulties in the way of constructing and maintaining them. I do not see any difficulty in creating a harbor on the Pacific, but I do see difficulty, not in creating, but in maintaining one on the Atlantic side, and if any of you will see the length of the line of coast directly east from Greytown, you will appreciate how long a breakwater will have to be built, how far out it will have to be built, before the direction of the prevalent wind will be at right angles to the bank that is formed between the breakwater and the present coast.

Mr. Menocal: How far?

Major SHELBOURNE: I think the coast extends almost directly eastward from the entrance to Greytown harbor for a distance of a mile to two miles.

Mr. MENOCAL: And how long will the jetty then have to be?

Major SHELBOURNE: Well, that is a mere matter of engineering calculation.

Mr. MENOCAL: Oh! and I suppose you have not studied that?

Major SHELBOURNE: Oh, I don't assert that a harbor cannot be maintained there, but any jetty built will be only temporary in its effect, and it will continually have to be extended.

Mr. MENOCAL: The question is how far it will have to be extended before we have the sands drifted by the action of the winds at right angles with the present coast?

Major SHELBOURNE: Well, my impression is that the coast extends a mile, or a mile and a half directly east. Now, if the winds strike that coast at an angle of 45°, that jetty will have to be extended to make a right angle with the coast. If Mr. Menocal will be present at any future discussion, I will be careful to make the estimates, and tell him how long the jetty will have to be before the conditions he desires will be attained.

In regard to the matter of locks, and the time of passing through them, that is a matter for every engineer to judge for himself. I want to say, however—though I do not wish to be understood as offering it as a valid objection against the lock system—that if you calculate the area of the present pipes that Mr. Menocal has located in his locks to fill them, taking the velocity of the inflowing water at 10 feet per second, it will take, as you will find, some eighteen minutes for the water to fill them. I do not say those pipes cannot be increased, but I do say the present estimates are wholly inadequate. I think it is fair to remind the gentlemen present that the commission of which Mr. Menocal speaks, said that, as far as the scientific work in the surveys was concerned, they found no fault with it, but at the same time they say—and Mr. Menocal has so admitted in a paper he wrote for *The Engineering News*—that this commission found that in some instances the prices put upon this work were not altogether adequate.

Mr. MENOCAL: I think you are in error, sir. I did not say, "the commission," but "some members of the commission." The fact is, that there was but one out of the five, Major McFarland, who entertained that impression, but in writing that article I did not wish to seem personal, and so wrote "some of the members," instead of "one of the members," which would have been correct.

Major SHELBOURNE: I do not stand here to correct the gentleman as to what he said on a former occasion. I simply say that to bring the prices on a par with those upon which the estimates of the other routes are based, is to add for two items alone an increase of about thirty-one million dollars to his estimates.

In regard to this matter of earthquakes in Nicaragua, and the different parts of the isthmus, the fact appears to be this: When you take the very narrowest parts of this isthmus, as it is at San Blas, and very little more between Panama and Colon, you find that it is not altogether free from slight shocks, or tremblings of the earth, but they were never known to have done any damage. You know some years ago, Caraccas, which is on the body of South America, had a very severe earthquake, in which the whole city was destroyed. I have not enough data by which I can say that my remark will be borne out by experience or scientific conclusions, but it appears to me, from the data I have seen and the information I could gather, that where the continents begin to widen out, so as to form a broad area, that earthquakes are more numerous and more severe. When you get into the body of South America the earthquakes are sometimes very disastrous, and you know earthquakes are very severe in Mexico. The idea seems to me to be this: Here you have a narrow region of isthmus with more or less depth of ocean on each side, and, as an earthquake must be due to internal commotion of the earth—volcanic or whatever you choose to call it—and will be disastrous in proportion to the resistance offered to that force finding its exit on the line of least resistance; so, if you take the isthmus at San Blas—1,500 feet high and very narrow—there it would seem the earthquake force would find its way out without any great resistance, and consequently without provoking any very great effect, but in South America it would have to exert a greater power to find the line of least resistance and effect its exit. So above in Nicaragua also, where the isthmus is wider.

There are other points, but I hardly feel like taking time this evening to develop them.

Mr. MENOCAL: I would like to say, in regard to the gentleman's proposed alterations in my estimates, that from all the information

I have been able to obtain, I am led to believe that the excavations, under water as well as out, can be executed along the whole route for the prices stated in these reports, and a very responsible person here in New York has told me they would be very willing to take the contract for all the rock blasting and dredging at the prices estimated.

As to the winds on the lake. I have said, and I say, that the winds do not prevail on that portion where the lake would have to be dredged, as that part is shielded by mountains. It would therefore be necessary for a vessel to be towed along the river and into the lake until she got a fair wind, beyond this sheltered corner, and then her way would be open for her all across the lake, for progress by the aid of her own sails.

As to the channel through the swamp, it is not proposed to bank the excavated material, but to dump it in the little lakes and the lower channel of the San Juan.

Q. What is the material ?

Mr. Menocal : Sand and clay, and as to a doubt of its standing a slope of 1½ to 1, I will simply say that the natural banks of all these lakes, as they stand, have a slope of ½ to 1, so that they have deep water very close to the edge. In that little lake (indicating upon the map) you have ten feet depth of water within five feet of the edge, and the center depth is 16 feet. All this material, as has been said, it is proposed shall be dumped into these little lakes and the channel specified. There is no proposition to form dykes on the sides of the canal.

Q. How high are the natural banks around those lakes ?

Mr. Menocal : On the south and west sides they are high, though I do not remember the exact altitude now, but all this (indicating the other margins on the map) is low land.

Q. How far does that river extend across the channel, and what is its character?

Mr. Menocal: It is simply an outlet of the Rio San Juan, and it is proposed to cut it off altogether, which can be done very easily.

Q. Do you propose to blast any rock in a current like that at Hell Gate?

Mr. Menocal : Oh no, not at all. There is a short place where we might have to blast at a depth of nine feet, in a current of five miles an hour, and as we blast away the rock which acts as a dam, the current will increase, but it can be at no point so violent as to offer any serious obstacle to the work.

Q. You have spoken of it as trap rock. Is it at all similar in character to that about here?

Mr. MENOCAL: Oh no. It is loose and fractures easily, while this you have to encounter here is very hard and compact.

Q. Hard rock, like granite, would increase the cost of removal?

Mr. MENOCAL: Yes; naturally. But I can say that responsible persons here are willing to take the contract for all that work at the prices named in the estimates. Those estimates are correct, and no engineer of reputation, conversant with the facts, has—heretofore—criticised them.

Mr. A. L. FORD: So far as it affords an indication of the actual cost of earth excavation in that country, I will say that a large contract has just been made in Nicaragua for the construction of 80 miles of railroad, and the contract has been taken by Mr. Norris. His basis of figures for the earth work is on 30 cents per cubic yard for all kinds of earth, not merely light loam, but stiff clays and some swamp; and he based his figures on calculations including the rainy season and a prospective increase in the price of labor—for the entire labor market of that country is affected by a contract of such magnitude as building 80 miles of railroad.

Mr. MENOCAL: I would like to call the attention of engineers to the fact that, in the construction of the proposed canal across Nicaragua, the work is not concentrated at any particular point, but extended along the whole length of the line; so that the men can be put to work at the same time from one end of the canal to the other, and the work can be completed in a relatively short time as compared to the time that would be required to build a canal by either the San Blas or the Panama routes, where, on account of the proposed tunnel and of the deep cuts, only a limited number of men can work at once.

Chief-Justice DALY: It is now twenty minutes to eleven o'clock. This discussion will be continued next Monday evening, until which time this meeting will stand adjourned.

INTEROCEANIC SHIP CANAL.

Special Meeting of the American Geographical Society, held at their rooms, on the evening of Monday, December 22, 1879.

Among others, there were present—Chief Justice Daly, the President of the Society, Mr. William H. Webb, Mr. John E. Body, General E. W. Serrell, Civil Engineer, Mr. Elial F. Hall, Mr. Octave Chanute, Mr. D. S. Moulton, Mr. Jess Young, F.R.G.S., Major Sidney F. Shelbourne, Mr. James M. Bowman, and Mr. Simon Stevens.

Upon calling the meeting to order, the President said that it was the intention to devote the evening to the consideration of the San Blas route for an isthmus canal, the last meeting having been given to the consideration of the Panama route, which led to the presentation of claims on behalf of opposing routes, among which was the San Blas.

The PRESIDENT said : Before the investigation commences, I think I should call the attention of those present to the fact that an address was made before the Committee on Technique, which, as I understand it, was the chief scientific committee of the Paris Congress, appointed to examine preliminarily the various routes, their advantages and disadvantages, by Mr. De Courcey, a civil engineer. The fact that he addressed such a committee is of itself an indication that he was a person of some consequence in their estimation ; and that his address was considered of importance, I infer from the fact that it has been translated and published in the last number of the *Popular Science Monthly* in this country.

I wish to call attention to three statements that he makes, one of which is certainly very extraordinary for a civil engineer professing to speak upon a subject with which he assumed to be acquainted—that is, to the effect (I give his language as in the translation) that to carry out the San Blas project a harbor must be built on the Atlantic. Now, it is known to geographers—at least, to all American geographers—that the bay of San Blas is a very remarkable one, and that in the northwestern portion of that bay, at the mouth of the Mandinga river, which is to be the mouth of the projected canal, there is a very fine harbor capable of accommodating vessels of any depth of draft. At least, that is the fact unless all the information we have hitherto received is unfounded, and Mr. De Courcey has information which we do not possess.

The other statement is, that at the mouth of the Bayano river, which is to be utilized for the canal on the Pacific side, and at the mouth or near the mouth of which the canal is to terminate—that on that side there is a bar which he says it is by no means certain can be mastered. He may be correct in this statement, for I am not particularly informed in regard to the mouth of the Bayano; but there are gentlemen here who are, perhaps, informed upon that subject, and who can tell us whether there is such a bar, and whether the difficulties are so great as Mr. De Courcey suggests.

The last statement is in respect to the proposed tunnel on the San Blas route. He says that shipmasters do not take kindly to a tunnel with so long a passage without fresh air; that they will have an unconquerable antipathy to passing through it, even with the aid of an electric light. The passage through this tunnel as estimated, so far as I understand, will occupy about two hours—which amounts to the proposition that a shipmaster, from his "unconquerable" repugnance to a tunnel, would prefer carrying his ship around Cape Horn instead of going through a tunnel in a passage of two hours.

I mention these three facts, as they are reproduced in a publication here for the information of the American public, to show how, in my judgment, even in the most important committee of the Paris Congress, they were misled in respect to the true facts by gentlemen professing to have knowledge of them.

Major Shelbourne, who was heard on the previous evening in a criticism of Mr. Menocal's exposition of the Nicaragua route and its superior advantages, is here. If he is willing I will call upon him, and we shall be glad to hear from him as full an exposition of the San Blas route as he is disposed to make, giving us as far as he can an exact account of what is proposed to be done, the nature of the country through which it is proposed to pass, the character of this tunnel, and, so far as such a matter can be now judged of, its estimated cost, or any other matters which he deems essential in connection with it.

Major Sidney F. Shelbourne then came forward and spoke as follows:

ADDRESS OF MAJOR SIDNEY F. SHELBOURNE.

THE NICARAGUA ROUTE.

Major SHELBOURNE said : Mr. President and Gentlemen,—Before entering upon the principal subject of discussion for this evening, I beg your indulgence for a moment while I return to a detail of the Nicaragua route, which was under discussion at your last meeting, a week ago, and in which Mr. Menocal undertook to question a statement that I had made in reference to the breakwater or jetty, and the silt that would throw around it. His statement was to the effect that the jetty would be, as I understood him, some 600 feet long from the shore, and that it was intended to stop the drift of the sand along the coast, as it is now formed there, at the harbor of Greytown, and that eventually the condition would arrive in which the northeast trade winds, which now strike the present coast at an angle of 45 degrees, driving the sand along it, would fill up the angle to be formed by the breakwater with the coast so as to create a shore-line at right angles to the direction of the wind ; and thereafter the sand, instead of drifting westward in the direction of the proposed outlet for the canal, would be turned in another direction, and be driven towards the south.

I stated that the coast at that point trended almost, if not directly east, for a distance of between one and two miles. I had not made an exact measurement of the distance on the scale, and the question which Mr. Menocal put to me was as to the length of the coast trending directly eastward along which the sand would drive. Not wishing to speak at random, I said I would make a calculation, and at the next meeting of the Society I would present it.

Those of you who can see this portion of this map will see the direction of that coast. That point [referring to a location on the coast as delineated on Map No. 4, accompanying the report of the surveys of the Nicaraguan route by the United States government] is the proposed breakwater. It is not proposed to be built at right angles to the coast, but at an angle of about 115 degrees with the trend of the coast. I have produced here [exhibiting a diagram of the coast and an extended breakwater on a scale of one mile to the inch] a rough idea of the conditions which will obtain. This coast, from the place where the breakwater is proposed to be built out from it, trends directly east, as you see by the map, not a mile and three-quarters, as I stated, because I did not want to speak without exact knowledge, but I find, upon a calculation upon the plans and maps made by Mr. Menocal himself, that the direction of this coast eastward is for a distance of two miles and ninety-three one-hundredths from the point where the breakwater is proposed to be built. I stated that the sand driving along that coast would very soon fill up the angle between the shore and the end of the breakwater; and then the breakwater would need to be continually extended in order to prevent the sand from drifting into the mouth of the canal. You will see, then, since the northeast trade winds strike this three miles of coast at an angle of 45 degrees, the conditions for turning the sand in another direction, which Mr. Menocal hopes to attain, will not arise in Greytown harbor until this breakwater is extended out a distance equal to the distance from the shore end of the breakwater to the point eastward where the coast faces off towards the south, which is about three miles.

The length of the breakwater, as it is proposed to be built, if I understood Mr. Menocal's statement correctly, would be represented on this diagram of a scale of one inch to the mile, by a line only one-eighth of an inch in length. But the condition of safety for the canal would not be attained until the breakwater actually built could be represented on this same scale by a line nearly three inches in length, so that when the breakwater shall have been extended for a distance of three miles from the shore, and the angle formed by it with the three miles of coast should become filled up with sand, the wind would then drive the waves bearing the sand at right angles to the new-made shore, and the movement westward would probably cease and possibly the sand find an easier lodgment in another direction. Now, 600 feet is a little less than one-eighth of a mile; consequently, if the breakwater is to be 600 feet long at the commencement, it would have to be extended twenty-four times its whole length before the condition of security would arise. The danger of the sand drifting into the mouth of this canal around the breakwater, and its rapidity of lodgment, will be apparent to you when I repeat Mr. Menocal's own statement that a half million of cubic yards of sand and debris is brought down by the San Juan river and fed to the waves of the sea through its outlets at and near the harbor of Greytown—a half million cubic yards every year.

Mr. Menocal has said that all engineers who have examined his plans for a breakwater here at Greytown have approved of them, and that they were approved by the Paris Congress. I think you all will approve of this proposed breakwater as a makeshift for the present, and as the beginning of a very prolonged struggle with a herculean difficulty. However, Mr. Menocal himself states that it will need to be extended from time to time. In that statement he admits the whole objection. I should approve of it, too, if the Nicaragua route were the only canal route, and every engineer can see that to build a breakwater or jetty at right angles to a coast along which the sand is driven, will stop the sand for a certain length of time.

THE SAN BLAS ROUTE.

Turning from the subject of the Nicaragua canal to that of the route by way of San Blas, I have to say, in the first place, that every feasible and available route except San Blas, every route that is now brought to the public ear, has had its government surveyor and its official volume, containing very extensive letterpress and numerous detailed maps; but the San Blas route has nothing to represent it that the government did or paid for, except two small maps among seventeen contained in Commander Selfridge's report, the letterpress of which, relating to the San Blas route, is comprised in six pages.

It was the great misfortune of the San Blas route that a private citizen spent his money and sent his engineers down to the isthmus some six or seven years before the first of the prominent government surveys were made, and the fact that he thus surveyed this route, and made his map of it, and advocated it, so that it was called the "Kelley route," was enough to condemn it in the eyes of the government officials. A naval officer does not take his cue from a civilian, nor, if he can help himself, does he propose to take a secondary place in any project, scheme or exploration that a civilian has commenced and carried to a certain progress of demonstration. Therefore the naval officers—each one who made a survey upon the isthmus—had routes of their own, and Selfridge, who merely went to the Gulf of San Blas after the beginning of the rainy season, and spent a few days there and made a reconnoissance up the mountain, following the crooked beds of the watercourses and a partial and tortuous chain and level survey upon the ridge, in his report elaborates a route that his own name could lead, the Atrato Napipi route, and the great bulk of his maps are devoted to the detailed plans of that route, commencing in the Gulf of Uraba, and ascending the Atrato river for 150 miles, and reaching the divide in the general line of the valley of the Napipi with a tunnel through the ridge, and with locks down to Cupica or Limon bay on the Pacific. The Tehuantepec route, surveyed under Captain Shufeldt, has its volume bound in red, perhaps because it is a demonstrative color. The Nicaragua route has its volume, the final survey being made under Commander Lull. The Panama route has its volume, and, as I have just said, the Atrato Napipi route dwarfs everything else in the voluminous theme of Commander Selfridge. I will not, however, undertake to explain how it happens that each naval officer has come to have his judgment invariably set in favor of that route the report of which bears his own name in large capitals on its title-pages. It is, undoubtedly, natural that a father should love his child, and wish, too, to be publicly recognized as the father of his own.

But if the officers of the United States government have failed to give to the San Blas route that attention which it deserves, and if it is not represented before you to-night by a detailed report of a government officer and by maps of profiles and sections, and plans and minute details, elaborated at Washington, it may fortunately be said that nature herself has presented her strongest arguments for the San Blas route, and the geographer, true to her, as he hopes to declare the merits of his work, has delineated them in every school atlas, and they may be found upon the shelves of every scientific society. It is enough to say that it has long been shown in all atlases that at San Blas the isthmus comes to its very narrowest—less than 27 minutes of a degree of latitude—as Mr. Sweet makes it, and Mr. McDougal's survey, 30 miles and a small fraction. Commander Selfridge, however, represents it in his report as being 37 miles from ocean to ocean. How he arrives at this length I cannot imagine, while on his map, according to the scale, the whole direct distance across from ocean to ocean is a trifle under 30 miles. As this latter distance agrees, within a few feet, with the results of McDougal's survey, it should be assumed to be substantially correct. If Commander Selfridge had taken the trouble to determine the true latitude and longitude of the shore on the Pacific side at the mouth of the Bayano river, we could have known the exact distance across the isthmus at this point to within at least 150 feet. None of these maps which are hanging on the wall before you will show the direction to the Gulf of San Blas from New York; but bearing in mind that the longitude of New York and the eastern point of Cuba is about the same, being 74° west from Greenwich, the route as far as Cuba will be in a great circle, and taking what is called the windward channel, we pass the eastern extremity of Cuba, and then bearing southwest by south, we also pass the eastern point of the island of Jamaica, striking the Gulf of San Blas on a direct course, and passing Point San Blas on a south-west by west course, we enter the magnificent harbor of Mandinga. Now, the distance from New York by the passage I have delineated to the proposed San Blas canal is 85 miles less than that by the same windward channel to Greytown, the Atlantic terminus of the proposed canal through Nicaragua. We will commence with the exposition of the San Blas route on the Atlantic side, while on the Nicaragua route they have usually commenced on the Pacific side. We reach, then, across this open sea, the Gulf of San Blas, as represented upon this map [referring to Mr. Kelley's map of the San Blas survey loaned to the society], and 85 miles nearer to New York, as I have said, than Greytown. This map was made by Mr. Sweet, one of Mr. Kelley's engineers engaged in the survey. This survey was made in 1864, under the auspices of Mr. Kelley and Mr. Cyrus Butler, and no complete survey of this route has ever been made since, but only a reconnoissance and partial survey by Commander Selfridge in the expedition of 1870. The engineers of Mr. Kelley commenced their survey upon the Pacific side. Pausing here, I will say that this harbor of Mandinga was surveyed by Commander Lull, then under Selfridge, but afterwards having command of the expedition which completed the survey of the Nicaragua route. It was commenced in April, 1870, and was completed during the time of the land survey of the San Blas route under the other officers of Commander Selfridge's expedition of that year. Lull spent twenty-five days altogether in the survey of the approach to this harbor, and in a trigonometrical survey of the harbor itself and the Gulf of San Blas. There is an area here in the harbor of as much as nine square miles, where a vessel can ride at anchor at all times with perfect safety. As you approach this harbor from the Gulf of San Blas through the channel which has been named after Admiral Porter, and pass the southernmost of an extended parallel group of islands which form its northeast boundary, the depth of the water in the harbor is 112 feet and as you pass inward towards the delta between the mouths of the Rio Mandinga, you have a depth of 30 feet within 300 yards of the shore. The bottom of this harbor is a clay and clayish mud, so you see it affords an excellent holding ground. The mouths of the Mandinga river are not shown upon Mr. Kelley's maps, except one of them, as you will see here by this slight shore indication, which was perhaps plotted afterwards from Commander Lull's survey of the harbor. The river Mandinga has two mouths opening into this harbor of the same name. The reason that Mr. Kelley's engineers have not located the mouths of the rivers Mandinga, Vercalagua and Carti, which open here into the gulf of San Blas, is that at the time their survey was made in 1864 this tribe of Indians inhabiting the Atlantic slope of the Cordilleras at San Blas had been almost entirely excluded from contact with civilization, and were very hostile. They were very jealous of the presence of strangers, and when Mr. Kelley's party of engineers and surveyors got over the ridge down to the low land—for about three miles the ground does not rise more than four or five feet above the sea level, and during the rainy season it is a part of the time overflowed—when they got down here the Indians made hostile demonstrations, and the surveyors were obliged to get back over the mountain.

I have here a small map, which Mr. Curren has kindly pinned up for me, which was made under the auspices of Commander Selfridge, and is map No. 12, accompanying the report of his expedition of 1870. It will show you the chief features of at least the Atlantic division of the San Blas route, and the details of Mandinga harbor and the Gulf of San Blas, for it was to these features, not examined by Mr. Kelley's engineers, that the most of his attention was directed. As this map is very poorly plotted, and as the lines are not in colors and not very prominent, it will be very difficult for those of you in the back of the room to see the details of this Gulf of San Blas. At any rate, I can explain to you that Point San Blas, shown on this map, is the point of the mainland the furthest towards the northeast of this whole region of the isthmus lying to the south, southeast of Aspinwall, and that it forms the northern shore of the large Gulf of San Blas, enclosed between it and the mainland, at the mouth of the river Carti on the south. The entrance to the Gulf of San Blas is from the direction of northeast by east. There are a number of outlying islands here, which protect the gulf and the interior harbor of Mandinga, and make it safe at all times. The entrance, however, into the interior harbor is by a broad channel, called, as I have indicated, Porter channel.

This Mandinga harbor, then, embracing an area of about nine square miles, is intended to be the Atlantic terminus of the San Blas interoceanic canal.

The two mouths of the Rio Mandinga are separated from each other by a distance of two and a half miles, while it is only one and a half miles in a direct line across the delta from the shore to the point where the river separates into its two outlets. Altogether, for a distance of three miles in a direct line from the harbor shore, the Mandinga passes through low ground, scarcely elevated above the sea, and then we begin to find rising ground as we ascend in its bed. If we were standing upon the slope of the Cordillera to the southwest, and looking towards Mandinga harbor and the Gulf of San Blas, and the dense verdure and intervening ridges did not obstruct the vision, we would see the Mandinga river on our left entering into the harbor towards the east; the Rio Vercalagua before us, and partly to the right, also entering into Mandinga harbor, further towards the right and in a northerly direction; and on the extreme right the Carti river entering into the Gulf of San Blas, in a northerly direction, near the easterly limits of the southern shore of the gulf next to the sea.

As the Rio Mandinga is quite to the left, and the Rio Carti far to the right of the proposed line of the canal, their peculiarities and water-shed do not enter into the problem before us, although both of these rivers find their source far up towards the centre of the isthmus. But the Vercalagua more directly interests us, because through a portion of its upper valley would the open cutting of the canal on this side of the Cordillera be made. It has its rise on the Atlantic slope of the Cordillera, about seven miles in a direct line from the harbor of Mandinga, and when you get three or four miles from the harbor, and strike its valley, it is nothing but a little mountain rivulet, sometimes dry, but in the wet season a little mountain torrent. The open cutting of the canal would strike the bed of this river at a distance of two miles from the point where the canal begins, at the harbor of Mandinga, and follow its bed in general direction for another half mile, when it again leaves its bed, and takes the valley to the right or southward of the stream itself, to the point where the tunnel would commence, five miles from the harbor of Mandinga. It will be seen, therefore, that the Vercalagua will have a new direction or debouchement given to it from a point two miles and a half from the harbor of Mandinga, by the embankment of the rock debris brought from the tunnel, and that its outlet into the harbor will then be near the southernmost mouth of the Rio Mandinga.

I will now go forward and locate for you the termini of the proposed San Blas canal, and give you the approximate length and character of its sections. Its Atlantic end would be in latitude 9° 26′ 56″ north and longitude 79° 2′ 50″ west, the harbor of Mandinga presenting at this point the nearest available approach southward towards the ridge of the Cordilleras. This end of the canal may be further located on the map by a distance of 2 miles 550 yards in a direction west by southwest from the mouth of the Rio Vercalagua. The first section would be five miles of open cutting in a generally south southwest direction. Then would follow the tunnel for a distance of seven miles through the Cordillera, varying but little in direction from a meridian of longitude, and terminating upon the Pacific slope of the range about a half mile east by northeast of the falls of Salto. From this point the canal would be led by an open cutting a distance of 12 miles into the Rio Bayano at its great bend, a point six miles from the Bay of Panama. And now returning to the Atlantic side, let us follow this work more in detail. The five miles of open cutting commencing at Mandinga harbor would pass for a distance of two miles through a lowland, which lowland is not a mud—not a soft mud—since it is composed of a reddish yellow clay in the main part, with some vegetable decomposition and dark alluvium upon the surface.

For nearly three miles the cutting would be quite light. I may say in this connection that the tide passes up this river, the Vercalagua, for a mile and a half, and the tide only rises and falls on an average eight-tenths of a foot in the harbor of Mandinga, so that you can see how little the rise of the ground must be for that distance, since eight-tenths of a foot brings the tide a mile and a half up that river. After you get three miles in a direct line from the harbor of Mandinga, the ground begins to rise rapidly until, at a point five miles from the harbor, you come to an elevation 190 feet above the surface of the sea.

It has been laid down, and seems to have been agreed to by engineers generally, and by persons who have studied this subject, since no one has presented adverse views, that when you arrive at a depth in open cutting of 190 feet above the sea that it would be cheaper and more desirable to make a tunnel. If this depth of open cutting, therefore, be taken as the proper one for commencing the tunnel, the length of the cutting of this depth would not be more than a quarter of a mile in the situation under our consideration, for the surface of the ground immediately falls down to an elevation of 166 feet, then to 130, 98 and 66 feet at the middle point of this five miles of open cutting, while the average of the remainder is but a trifle above the sea. It is to be observed, however, that when we add 28 feet, the depth of the canal below the sea level, to the 190 feet of open cutting above that level, we will have, for a few rods of open cutting just at the mouth of the tunnel, a depth of 218 feet, and the tunnel being proposed of a height of 168 feet above the bottom of the canal, it will be seen that there will remain above the arch of the tunnel at its commencement a roof of rock of a depth of 50 feet.

Two routes for the tunnel suggest themselves to those who have studied the features of this portion of the isthmus, slightly varying from each other in their outlet on the Pacific side; but which would be the most advantageous would depend upon more accurate surveys.

There have been a great many fears expressed, and a great many doubts entertained in regard to the feasibility of the tunnel—in regard to its cost—in regard to its utility after its construction, and in regard to the stability of its natural arch, involving the question of the probable necessity for supplying a masonry arch for the whole length of its seven miles.

Judge Daly: And the danger of the inflow of water?

Mr. Shelbourne: Yes, that is one of the expected difficulties—the infiltration of water through the rock into the tunnel while it is being excavated the 28 feet below the surface of the sea.

I wish, however, first to speak of the problem of the length of this tunnel. There is a wide discrepancy between the two surveys, or partial surveys, as we must call one of them, in regard to the distance through the Cordillera at an elevation of 190 feet above the ocean, and consequently in regard to the probable length of the tunnel. It will be worth the time to explain how that arose.

If you will follow the direction of the river Bayano, on this map of Mr. Kelley, up from its mouth at the Bay of Panama to the junction of the river Mamoni, and then up that river to the dividing ridge and over it, you will trace the principal line of survey made by Mr. Kelley's engineers. Commencing in the Bay of Panama, they made an accurate survey up the Bayano and the Mamoni, locating all the bends, banks, spurs of hills and points of shore, and passing in the same way up the Mamoni, skirting a spur or ridge of hills on their right, which approaches from the east close to the Mamoni, they came up that river to the falls of Salto, in the first range of the Cordillera on that side through which the tunnel would have to be made. Knowing the general direction of the proposed tunnel to be north from the point where they were, they took the bend of this first range of the Cordillera, and found, instead of its being directly east and west, that it fell away toward a point north of east on their right; they therefore surveyed along the foot of this range towards their right for something more than half a mile, and located the Pacific end of the tunnel, as they thought, in the most favorable and advanced position northward to be found in the base of the mountain. Returning to the Mamoni, they continued a chain and level survey up the circuitous valley of this river, noting every angle with their instruments, and coming to the sources of the Butler river, a north and south branch of the Mamoni, they passed over the divide, and finding the head-waters of a branch of the Samgandi, they passed down the Samgandi and the Mandinga, with which it joins, to the base of the Cordillera on the Atlantic side, where, as I have said, they were driven back by the Indians. Now, as far as the mountain itself is concerned, this survey of Mr.

Kelley's engineers, although it was a series of circuitous valleys, was, nevertheless, unique and complete, and the determination, upon a scale, of the consecutive series of angles obtained, will give us the distance in a straight line from one side of the mountain to the other. That they did not go from the base of the mountain on this Atlantic side to the harbor of Mandinga, here shown on Selfridge's map, and obtain the exact distance, and locate the mouths of the rivers which flow into the harbor and gulf, and get the topography of the harbor and the bearings of this point of San Blas and all the locations hereabouts, does not make any difference as regards their survey of the ridge of the mountain.

You see that this map [referring to map 12 of Selfridge's report], so far as the Pacific side is concerned, was made entirely from Mr. Kelly's survey. Here is almost, if not quite, a complete copy, on a reduced scale, it is true, of the curves and bends and direction, and everything else, of this river Bayano. Nobody made a proper survey of this side of the isthmus for this route, except Mr. Kelley's engineers, that I am aware of. Mr. Kelley's engineers passed over this ridge entirely. Mr. Selfridge's engineers, when they made their survey six years later, commenced on the Atlantic side in the harbor of Mandinga, and passed up the valley of the Mandinga river and its branches, in the same circuitous way in which Mr. Kelley's engineers came down, until they passed over the ridge, and came to the junction of the river San Jose with the Mamoni, where they fixed upon the marks of Mr. Kelley's survey, and joined their line with his. Commander Selfridge says, in his report, that they met Mr. Kelley's survey at the junction of that river, San Jose, with the Mamoni, and that they found there only half a mile of difference or variation between the location of that point, as determined by his own surveyors and the surveyors of Mr. Kelley. And he says further, that this half mile of variation shows the accurate work of Mr. Kelley's engineers, for they took their base line from the coast line of the Pacific, while his own party took their line from astronomical observations; and he says of the Pacific shore line, that it "is doubtless half a mile in error." Now, Mr. Selfridge's surveyors, in plotting this map [No. 12, before referred to], went to work to join their survey to Mr. Kelley's surveys, and they brought out this sheet accordingly. It is a hybrid production, part of one sort and part of another; and in the merging together of two surveys it may be readily understood how, when they plotted their map, they could make upon it the distance through this mountain here, in a direct line, to show ten miles or any other imaginable approximation. That there is an error in this map [No. 12] is apparent, for this reason. You will observe the direction of that ridge of the Cordillera [the first extended ridge on the Pacific side on which are located the falls of Salto]. As it has been plotted on this map [No. 12] it is almost at right angles, if not at right angles, to the proposed direction of the tunnel. Upon the general map of the Isthmus of Darien [map No. 1, accompanying Selfridge's report], that range of mountain immediately to the eastward of Salto falls turns to the northeast until it meets the longer range bearing south of east. By measuring the distance from a fixed point on the Bayano river, on the scale of Selfridge's map, to the points of this range of the Cordillera, as shown on the map, and comparing these distances with the same distances as determined on the scale of Mr. Kelley's map, from which the other was made, an error appears in Commander Selfridge's map, in a single particular alone, of one and one-half miles. I compared the distance and pointed out the error to General Newton, who seemed to agree with me that the method of detection was conclusive.

Another point is this: In determining the length of the tunnel through this mountain to be ten miles, Commander Selfridge took his starting point on the Atlantic side from the valley of the Mandinga and his elevation above the sea at 160 feet, counting 30 feet for the bottom of the tunnel below the sea level to make up the 190 feet for his tunnel starting point. Now, the valley of the Mandinga, looking down the Atlantic slope, is quite to the left and decidedly away from the direct and shortest cut through the mountain, and his elevation of 160 feet in the Mandinga valley is much to the rear of the point adjacent to the valley of the Vercalagua, where the tunnel would commence.

A further indication is worthy of notice. A member of the party which surveyed the Rio Vercalagua, states in his report that the mouth of this river has a direct south bearing from the point of San Blas, while in fact it is located on Commander Selfridge's map nearly four miles to the westward of that bearing. If the reporting officer had made that statement of the mouth of the Rio Carti, either the map or the officer would have come within two-thirds of a mile of the truth. These various particulars, then, show that this map of Commander Selfridge, being plotted by the surveyors who made a partial survey and appropriated Mr. Kelley's surveys for the rest and filled up a gap of half a mile at the point of junction, is altogether unreliable as to the distance through this mountain and the length of this tunnel; while Mr. Sweet, who has in his notebook every particular of his work over this whole ridge, since this question came to be talked about and since the sitting of the Paris Congress, has gone over the details of his map and the length of this tunnel, and he cannot find any error in it. So that it may be taken for granted, upon all the best information that we have at present, that this tunnel will not be more than seven miles long.

Judge DALY : At what point of elevation do you place the commencement of this tunnel ? I ask the question for this reason : If I correctly recollect, Commander Selfridge in his report states that the tunnel will have to commence at about 350 feet of elevation, assuming that he makes the distance ten miles.

Mr. SHELBOURNE : 190 feet above the sea is assumed as the elevation for commencing the tunnel. I am not aware that Commander Selfridge so spoke of the San Blas route. I cannot find any such statement in the text of his report. He speaks, however, in a supplement to his report, of a possible lock canal on this route, with thirty-one locks, to gain an elevation of 372 feet, and then a tunnel of seven miles through the ridge. It may be, though, that he has made some such statement as you name of the Napipi.

Judge DALY : I think not. I will send for the report.

Mr. SHELBOURNE : We then have the length of the tunnel, as far as we are now able to determine it.

I want now to advert to the method which was very feasible to Commander Selfridge, with the facilities at his command, for determining the length of this tunnel astronomically. You will observe that the direction of the tunnel is almost exactly upon a meridian of longitude; that is, the question of longitude, for determining the length of the tunnel astronomically, does not come into the problem. Conceiving that such a simple method of determining the length of that tunnel would be feasible, I wrote to the Naval Observatory at Washington, and I have a letter from Rear Admiral Rodgers, which, with your permission, I will read :

U. S. NAVAL OBSERVATORY,
WASHINGTON, *September* 9, 1879.

Dear Sir: It is difficult to answer your question, since the skill of the observer is so important an element ; but in a night a zenith telescope may, in good hands, be put up and a result obtained for the station, with a no greater probable error in latitude than the quarter of a second.

With this error assumed for each end of the line, the probable error in the length of the tunnel, supposing that the stations are upon the same meridian, will be found by this formula :

$$\pm \sqrt{(0''.25)^2 + (0''.25)^2} = \pm 0''.35.$$

This represents a probable error of some 36 feet.

Yours very respectfully,
JOHN RODGERS,
Rear Admiral, Superintendent.

I also wrote to Professor Peters, of the Litchfield Observatory at Clinton, and he writes :

LITCHFIELD OBSERVATORY OF HAMILTON COLLEGE,
CLINTON, N. Y., *September* 16, 1879.

SIDNEY F. SHELBOURNE, Esq.

Dear Sir : An experienced observer, with suitable instruments, should be able to determine the latitude of a place by one night's work to within one or two seconds of arc, that is, about to within 100 or 200 feet.

Yours respectfully,
C. H. F. PETERS.

Both of these eminent gentlemen agree, then, that with such a telescope as Selfridge had at his command, his parties might have placed their station of observation at an elevation of 190 feet up the Rio Vercalagna on the Atlantic side from the harbor of Mandinga, and in one night made an observation; and upon the Pacific side at an elevation of 190 feet, and in one night made an observation, which would have determined within at least 200 feet the length of this tunnel, and settled this question upon the basis of fact, and not upon that of conjecture. But these observations were not made, and while the party attached to Commander Selfridge's survey had an astronomical station upon the shore of the harbor of Mandinga and determined its position, we have no account of any observations made anywhere on the interior of this route or on its Pacific side. It was Lieutenant-Commander Eastman who made a hydrographic survey of the Bayano river on the Pacific side; and in regard to the point that Judge Daly mentioned at the opening of this meeting, as coming from a statement made by a member of the Paris Congress before the Committee on Technique, that an insurmountable bar existed at the mouth of the Bayano, I will say that the report of the officer making the survey says that a bar had been located there by all the charts with not more than six feet of water on it, but that he found no such bar; but, on the contrary, a channel into the river of a depth of 15 feet at low water, sufficiently wide for all practical purposes. The average rise and fall of the tide at the mouth of this river is 16 feet, as laid down by the surveys, making a depth of 31 feet, without any further improvement, at high water. I should say the spring tides, which occur at the full and new of the moon, rise sometimes as much as 21 feet, but the average rise and fall of the tide is 16 feet. This river, from its mouth up to and beyond the point where the canal enters into it, has a depth of 15 and 18 feet, and in parts as high as 25 feet at low water, giving also at high water from 31 to 41 feet without any further improvement.

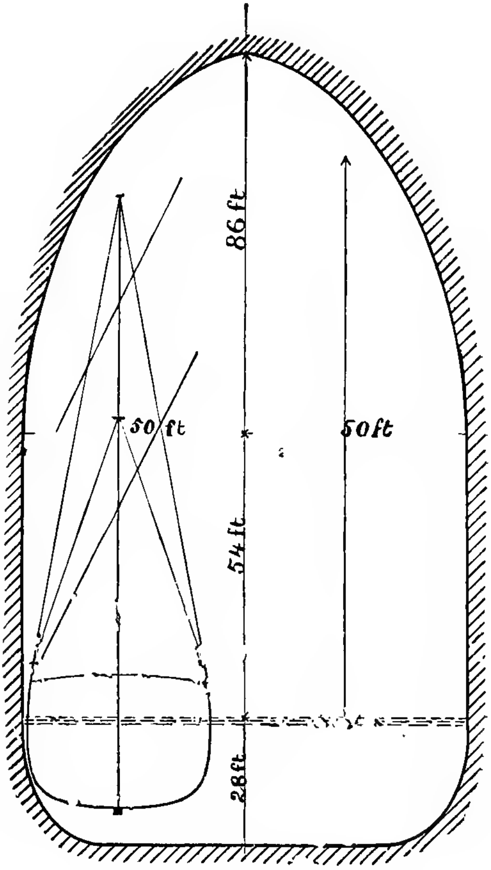
Judge DALY : Does that extend as far as the tide extends ?

Mr. SHELBOURNE : No, sir ; not as far as the tide reaches. You will see that the river makes a large but sudden and very closely returning bend here where the canal would enter it. The distance from this bend and the canal cutting to the mouth of the river is six miles, and it is for that distance that I speak when I say that the survey shows there is from 15 to 25 feet of water in the river at low water. The tide extends up this river, as the river runs, for a distance of 27 miles ; but as you come up around this great bend where the canal enters the river from the northward, the river has its direction quite from the eastward and away from the line of the canal, so that you see, as the canal enters the river comparatively near its mouth and a long distance below the head of tidal action, any freshets in the upper reaches of this river cannot materially affect its level where the canal enters it. As you pass up the river from this great bend, its bed rises more rapidly until you arrive at the head of the tide—that is to say, that the river at the head of the tide would have an elevation of 16 feet above the river at its mouth in the bay of Panama, and the tide would influence the river up to that elevation, or, more correctly speaking, to a point where the ordinary surface of the river is elevated 16 feet above the surface of low water in the bay of Panama, a distance of about 27 miles. The head of the tide water in this little river, the Mamoni, closely adjacent to the line of the canal, is in a direct line from the great bend where the canal enters the Bayano, a distance of four and one-sixth miles ; so that it is apparent that the depth of open cutting in the canal for this distance will vary only up to

16 feet above low water in the Bay of Panama, and from the head of tide in the Mamoni to the base of the mountain, where the tunnel would commence on the Pacific side, the elevation above low water would vary from 16 feet to 75 feet close up to the base of the ridge. The exact length of cutting from an elevation of 75 feet to that of 190 feet I have not been able to determine from the data I have had before me, but I should say less than one mile.

It will be observed that that part of the Bayano river to be utilized in connection with the canal has a width of nearly half a mile for one-third of the distance from its mouth.

Now, in regard to the tunnel and its proposed width and height. I have had a drawing made which will represent to you the section of the tunnel :



There have been various widths proposed for it, from 60 to 80 feet. Considering that it might be desirable that the largest vessels now afloat should pass each other within the tunnel—one going in one direction and the other in the opposite direction—and considering the progressive size of the vessels of the future, I have made this tunnel 100 feet wide at the surface of the water. It is also 100 feet wide at a depth of about 14 feet below the surface of the water, and to a height of 54 feet above it. Angles are avoided in the bottom of this tunnel, and the sides are seen to curve inward towards the floor, leaving a convenient fillet of rock in the corners. The height of the tunnel altogether, from the bottom to the top, is proposed to be 168 feet, with a depth of water of 28 feet. The springing of the arch is to begin at 54 feet above the surface of the water, and continue thence a further perpendicular height of 86 feet to the crown—making the latter point 140 feet above the surface of the water.

The drawing shows, in its left-hand section, a representation of the ship *James Nesmith*, a sailing vessel of 2,000 tons. The position of her topmast-head is shown when the side of the vessel is against the side of the tunnel. I have shown it in that way in order to answer the objection of those who argue that a vessel coming in contact with one side of the tunnel would injure its masts, yards and rigging against the decline of the tunnel arch. The yards of the vessel are shown cock-billed—that is, having one end of them brought downward on an inclination as shown in the figure. Both ends, therefore, of the yards are brought within the perpendiculars of the sides of the vessel. It will be seen by this drawing that, when the side of that vessel is against the side of the tunnel, the topmast-head will not touch the arch—it comes, at least, 10 feet from the decline of the arch. The width of this ship is 41½ feet. The figure shows the space between the central line of the tunnel and the body of the ship when she is placed next to the side of the tunnel; consequently, two such ships might pass each other in this tunnel, leaving a space of 17 feet between them.

The arrow-head in the right-hand section of the drawing shows the relative position of the topmast-heads of the steamers *City of Chester* and *City of Berlin*, of the Inman line, when passing each other in this tunnel. This arrow-head shows where the topmast-head of each vessel would come—the one on one side of the tunnel and the other on the opposite side—with reference both to the central line of the tunnel and the declines of its arch. I am told that the height of the topmasts of these steamers equals those of any now afloat. You see that the clear distance, sidewise, to the arch is about 8 feet; while, if one of these vessels were passing along in the central line of the tunnel, the vertical clearance would be more than 22 feet. I should say, at this point, that it is proposed to have longitudinal fenders fastened against the sides of the tunnel, of heavy timber, so that a vessel passing through it will never come in contact with the rock nor any of its roughness.

Again, sailing vessels in passing through the tunnel will always be in charge of a tug, alongside, and the tug being the lowest by far, with its smoke-stack and rigging, will take its position next to the side of the tunnel, keeping the vessel as near as possible in the central line of the passage. A steamer in transit can keep its direction and position with the greatest facility, for the water in this tunnel will be always quiescent.

In the work of excavating this tunnel it is proposed to begin at the top and excavate first a top section or heading of the main tunnel. This heading, or preliminary tunnel, as I shall call it, will have a vertical section of about 40 square yards, and, conforming in its arch with the arch of the main tunnel, will have its floor 15 feet below its crown and be about 30 feet in width; so that, at the sides of this preliminary tunnel, its roof would be 7 to 9 feet above its floor. If a section of 40 square yards be assumed for this excavation, a length of seven miles would give 492,800 cubic yards. Of course this preliminary tunnel is commenced upon each end—giving, so far, two working faces. If shafts are deemed desirable to expedite the work, it is designed to provide for three shafts, located at the most feasible points on the top of the mountain, and sunk to the level of the floor of the preliminary tunnel, and that would give us eight working faces altogether, if such rapidity of operation should be found necessary. It may be observed, here, that the St. Gothard tunnel is being excavated without shafts, a length of nine and one-quarter miles, and the whole time is a little more than seven years.

The cost of this preliminary tunnel has been placed at $10 a cubic yard, and would amount to $4,928,000. When the work I have just named is completed, all the tunneling work, which it is proper to name as such, is done. The rest is to be classed as work of another character.

Now, in regard to the price of tunneling work. A committee of the Paris Congress put upon the excavation of this tunnel upon the San Blas route, and, in fact, upon all the routes where tunneling was required, the greatest price that had been paid for the excavation of tunnels when they were excavated by hand-drilling and the explosive was gunpowder; and, more than this, they estimated the whole immense excavation, all of it, at the price for driving a small tunnel or heading, so that at $10 per cubic yard for tunnel, the San Blas canal, with 20,727,715 cubic yards of what the committee would call tunnel rock, would really amount to the total sum they named—somewhere about two hundred and sixty millions of dollars. This will show us how hasty and superficial were the calculations of the majority of those members of the committee having this subject in hand. Louis Favre, the contractor for the St. Gothard tunnel, did not place such figures upon the San Blas tunnel, for he made the cost at less than one hundred millions of dollars while estimating for a length of about nine miles.

Now, let us see how the question stands. The contract price for the Hoosac tunnel in 1869, for the entire excavation of the eastern section, was $11 per cubic yard; that contract was made in December, 1869, before the active era of nitro-glycerine, or dynamite, which is a modified form of the same substance, and before the use of machine drills in that tunnel, as it stood from the hands of previous operators. It was only after Mr. Shanly had got fairly at work under his contract that he introduced the Burleigh drill; and they kept perfecting their machinery from month to month and from year to year. Mr. Mowbray in 1869 was eagerly at work trying to perfect nitro-glycerine, so as to give the best results and make the explosive the least dangerous. Here, then, and in this condition of the art in 1869, with its inflated prices and gold premiums, there was a contractor who undertook to make a contractor's profit out of a small railroad tunnel at $11 per cubic yard.

The contract for the St. Gothard tunnel was made August 7th, 1872, and the contract price for the excavation of the tunnel amounts per cubic yard in our currency to $6.72. Here was another contractor who, thus early in the art, could find a contractor's profit in such a small tunnel at such low figures; but his mind was open to the future of his work, in the midst of the success of which he laid down his life. The vertical section of the St. Gothard tunnel is about 72 square yards.

Again, as to rapidity of execution in tunneling work: In 1863 the progress made in the Mount Cenis tunnel with hand-drilling and powder as an explosive was an average of a foot and a half per day. After they had commenced to introduce power drilling and the Sommeiller machine, the progress they made was three times greater—that was four and a half feet per day. When Louis Favre took the contract for the St. Gothard tunnel in 1872, the Hoosac tunnel was then in the rush of its progress under Mr. Shanly. Shanly completed his contract and made a provisional settlement December 22, 1874, and the tunnel was put to use the following year. Mr. Shanly said in 1874 of the machine drills used: "The use of the machine drills saved about two-thirds of the expense of drilling. The expense of labor would have been, I think, fully three times the cost of machine drilling. To have done this work by hand-drilling would have taken, I should estimate, not less than twelve years." This was the work, even at that time, accomplished in less than five years.

In the St. Gothard tunnel, from 1875 to 1877, with the greater perfection of explosives—for they had come to use nitro-glycerine by mixing it with an earthy material, making a compound consisting of seventy-five per cent. of nitro-glycerine and twenty-five per cent. of the adulterant and calling it dynamite, from a Greek word signifying power, and which is the standard explosive they now use—in 1875 to 1877, I say, with better explosives and improved drills, they made a progress of five to one; that is to say, they excavated their tunnel about five times as fast as was the progress in the Mount Cenis tunnel in 1863 by hand-drilling. Now, in the years 1878 and 1879, by the general improvement of the whole administration in the St. Gothard tunnel, they are making a progress of more than eight to one, or about 13 feet per day, through granitic gneiss, in a single heading. So that now, if they can excavate and remove rock from a tunnel eight times faster than they could fifteen years ago, you may readily see how much easier—how much more feasible—a tunnel has become to-day, on an Isthmus canal route, than at the time, in 1870, when the surveys of Selfridge were made. Indeed these naval officers, in their sphere of action, were ignorant of and had not conceived as possible these strides of inventive and engineering skill. How much value then—and I appeal to the judgment of each one of you—how much value must we now place upon the reports and opinions of these naval officers as to the comparative merits of a route, with a tunnel or without one, at the time their surveys were made?

The object of these surveys by the government was to find a low pass through the Cordilleras upon which they could construct a canal; and one of the conditions of the problem was that they should find a sufficient water supply to furnish the locks of the canal. They had hardly conceived the idea of making a tunnel; and if they were to have a tunnel as Selfridge proposed for the Napipi route, it was to be a short one, and only an absolutely necessary adjunct to permit them to realize the other conditions of water supply and a lock route through as low an elevation as it was possible to find.

I have a letter from Mr. W. Shanly, dated in September, in which he says that he would be willing to take the contract to drive the preliminary tunnel I have explained to you, for the San Blas route, for $9 a cubic yard. I have placed the cost at $10. Of course Mr. Shanly's price provides for a contractor's profit above the real cost of the work.

Now, in regard to the remainder of the work. You will see that when this preliminary tunnel has been excavated as represented by the section I have named, that only a very small percentage of the excavation has been accomplished. Engineers agree—Mr. Shanly has so stated, and Mr. Latrobe, and, I believe, Mr. McAlpine—and indeed it is clear to the mind of an engineer that when the preliminary tunnel is once driven the remainder of the work becomes nothing more than open cut work, with the extra advantage that you have the protection of a roof over you, so that the work with electric light can be carried on twenty-four hours a day the year round, without exposure to the vicissitudes of the weather, or the malarial atmosphere of swamps and vegetable decay.

Now, if the estimates for open cut rock upon the Nicaragua route, as its advocates have placed them, should be applied to this tunnel open cut work here, the result would be that the whole cost of the tunnel would be only $30,837,644, that is allowing $10 per cubic yard for the preliminary tunnel, and calculating the remainder at $1.25 per cubic yard. But I have endeavored to show on several occasions that the estimates of the advocates of the Nicaragua route for their open cut rock work are entirely inadequate. I have more than doubled their price for this class of work, and placed the excavation of the remaining portion of this ship canal through the mountain at $3 per cubic yard; so that the cost of this great tunnel—I mean the excavation of it—would be something like $65,000,000. I have the exact figures somewhere, but not just now at my command. If, however, sixty feet should be thought wide enough for the passage through the mountain, the cost would be reduced to about $40,000,000.

Every one who has objected to a canal route by way of San Blas has brought his first and chief objection and his last and reiterated objection to bear upon this tunnel: I suppose because all the other features of this route, except what lay in their ignorance, were admirable and pleasing to their minds, and the tunnel was the one thing to decry. They say that it is impossible to calculate its cost, and they assume to fear that the mountain would tumble in on the workmen, as if it were a quicksand, or that everything will be drowned out of it, as though it were a cloud of waterspouts. I have been careful in placing the figures upon this work, and I think they will cover the maximum. If the open cut work upon so large a scale as this could be done for $1.50 or $1.25 per cubic yard, you see that the whole cost would be reduced more than one-half the highest figures I have given; but I prefer to be safe in this respect.

After the preliminary tunnel has been driven into the mountain on either side for a certain distance, a multitude of workmen is placed upon this open cut excavation, and the tunnel is enlarged from the top downward in benches of rock and in convenient sections, always providing a depression for the drainage of infiltration. A track is laid in the tunnel and the debris is railroaded out on flats and dumped at either side of the proposed canal upon the low ground adjacent to the sea, and perhaps extending a certain distance into the harbor of Mandinga, and widening out on either side so as to form a convenient mouth for the canal.

But the great question has been whether the rock in the line of this tunnel would be homogeneous enough so that a natural arch would be self-sustaining—whether, in fact, the rock there was not entirely disintegrated and full of broken pieces, seams, cavities and cracks, so that, as we attempt to go through it, as one person expressed it to me, it would be like going through a mountain of cobble-stones. Indeed, some of the objectors seem to have agitated their minds into a lather of swollen apprehension on this subject.

It is sufficient to say that, through the base of the Cordillera upon this route, the rock is largely, if not entirely, granite rock.

Judge DALY: Is that the report of Mr. Kelley's engineers, or is it the surface indications?

Mr. SHELBOURNE: That is not the report of Mr. Kelley's engineers, because there were no geologists with Mr. Kelley's engineers; they made an engineer's survey. But this section of the isthmus has been examined, embracing both the San Blas route and the coast and interior further south at Caledonia bay, by J. Petigru Carson, mineralogist, and E. W. Bowditch, assistant mineralogist, of the expedition of 1870. Besides, the geology of the whole lower isthmus, embracing the Gulf of Uraba and the Atrato region, on the Atlantic side, and also the Pacific side, including the Tuyra region to the dividing ridge, and the coast from Limon Bay to Panama, and across on the line of the railroad to Aspinwall, has been examined and carefully reported upon by Dr. A. G. Mack, of Cambridge, Mass., and the specimens he brought home are now, by permission of the Secretary of the Navy, lodged in the geological collection of the Cambridge University. We have also various information from the works of older geologists and others who have exploited these portions of the isthmus, among them being Mr. Arthur Schott, accompanying Michler's survey of the Atrato-Truando region. On the San Blas route the boulders and other loose specimens found in the beds of the rivers up their courses were examined, and also the outcrop upon their banks and upon the various ridges of the mountain; besides, immense gorges of syenite were found, one of them extending for half a mile.

There is one very important thing, then, which can be said of this section of the isthmus that cannot be said of any other portion of it through which the various proposed routes for a canal pass. It cannot be said of Panama, nor of Nicaragua. It is this: that the San Blas Cordilleras are composed, on the Atlantic side at least, and through the bases of the main ridge, of the older crystalline unstratified rocks, granite and syenite, which is a species of granite. The common granite is composed of quartz, feldspar and mica. Syenite is that species of granite in which the mica is supplanted by hornblende. Now, these older crystalline unstratified rocks are the very oldest of all the rocks that appear upon the face of the earth. They are called primary in the books. Indeed, before any animal or vegetable life came upon the earth these rocks formed the ribs, we might say, of the continents. They are coeval with the foundations of the earth, so that we may write upon them an inscription quoted from the third canto of Dante's Inferno:

> "Before me created things were none, save things eternal."

This part of the isthmus, cutting it off near to Panama on the west and north on the one side, and taking the Bay of San Miguel and the Tuyra river over the divide to the Atrato valley and the Gulf of Uraba, as the limit towards the south and east—this part of the isthmus was originally a mountainous island. The whole of the lower valley of the Atrato river is an alluvial deposit. The part of the isthmus between the Bay of San Miguel, the Tuyra river and the Atrato valley on the north, and Cupica bay on the south, was upheaved long after the bases of the San Blas Cordillera appeared. This southern region shows the later tertiary formations. The same may be said in regard to the broken region between Panama and the Bay of Colon, which shows scarcely more than a series of detached hills, irregularly placed with reference to each other, like a lot of tumbled biscuits on a tray. The waters of the Atlantic and the Pacific were, at one time, united both in the region between Panama and Colon, and between the Bay of San Miguel and the Atrato valley, which was, in early ages, a part of the Gulf of Uraba, the junction of the two oceans being in the general line of the Tuyra river. So that we have to the north of this river the foundations of the Cordilleras range and its spurs composed of the primary unstratified rocks, and to the south of it, towards Cupica bay, the volcanic rocks, belonging to a much later era, and between the two formations, rocks of what is called the transition series. Here is a general map of that part of the isthmus, which I have taken from the series accompanying Commander Selfridge's report, and is map No. 1 of that series. You will see on it the general relation of the two divisions of the Cordilleras south and north of the Tuyra river. You will see, as you pass from the Bay of San Miguel up Darien harbor and the Tuyra river, the peculiar broad pockets and connecting reaches of water made by the banks, so unlike an ordinary river, and as you get up towards the ridge, or rather the depression or division between the two formations at the headwaters of the Tuyra, you will see how the mountainous section of the isthmus, on the north and east, is divided from that towards the southwest, so that, in a general way, they may be said to lap by each other. You see that the region at the headwaters of the Tuyra is filled also with numerous detached hills like the region at Panama, and the Rio Chucunaque, coming down from the far north and the middle of the older part of the isthmus, makes a very angular turn below Yavisa, and flows with the Tuyra towards the northwest and Darien harbor. Before the upheaval to the south, this river doubtless flowed into the passage between the two oceans, where now it makes its sudden bend to the northwest, and Darien harbor and the Bay of San Miguel are nothing more than the depression that was left after this later upheaval. In the fact of this passage here between the two oceans we may largely find the origin of the extensive alluvial deposits of the Atrato valley. The tide rising twice a day from 17 to 24 feet in the Pacific at this part of the isthmus, and scarcely 20 inches in the Gulf of Uraba on the Atlantic, the swift tidal current through the passage, always in one direction, must have carried immense quantities of alluvium with it. To the same cause I attribute the large swamp area adjacent to Colon in the Panama region.

Here, then, are two facts which mutually support each other. First, the fact that granite and syenite, both in mass and as boulders, are found *only* in the region of San Blas, and south towards the region of the Upper Tuyra, and nowhere else on the whole isthmus, from above Nicaragua southward, proves the fact that the transition rocks exist somewhere between the old and the new—and sure enough, the fact that the formations found in the Upper Tuyra region are of this series, and reveal their fossilliferous character by their marine shells, proves both the fact that the waters of the two oceans once joined in this region, and the fact of the older formations on the one side and the later on the other. So that, when the upheaval took place in the later tertiary period which closed this passage, these broken hills which were thrown up here partook of the character of each adjacent formation.

Again, as to the evidences of the character of the San Blas Cordillera, on the Panama side. We see that the continuous ranges of these Cordillera, running towards the west, terminate abruptly here, and are succeeded by a series of lower detatched hills, as I have said. None of these hills are of a granitic character, but are the result of volcanic eruption. The fact, however, appears that in the playas of the Chagres river at Mamey and at Matachin, we find the older crystalline pebbles, the granite and the syenite. Now, the Chagres has its sources in the high elevated San Blas Cordillera, from which these pebbles have been driven by the river current; but no pebbles whatever of a granitic character are found in the beds of the rivers coming from the opposite direction. The later eruptive origin, then, of the rocks on the Panama route, proves the fact that the Chagres river at one time found the waters of the sea at Matachin. This is also evidenced by the fact that, close to the highest ridge of this part of the isthmus, fossil corals have been found, and up the Chagres limestone deposits filled with fossil shells, while in numberless places along the railroad the strata of the volcanic tuffs are apparent, and quarries of it for the use of the railroad have been opened containing particles of gold belched out, and fallen into the sea or strait with the volcanic cinder.'

Following the isthmus northward to Nicaragua, we will find the rock to be of the same general character as at Panama. The geologist connected with the survey of the Nicaragua route says the rock they found there was mostly of the later tertiary period, volcanic, basaltic. They found some crystalline limestone, which belonged to the group of sedimentary deposit, and was slowly upheaved from the sea. I think, therefore, upon the evidence presented, the distincive fact appears that of all this region of the isthmus, commencing at Uraba, and away to Nicaragua, the only part of it where the primary formation appears—the oldest of all—the unstratified rocks, the granite and the syenite, is in the range of the San Blas Cordillera. This fact, then, of the character of the rock to be found on the line of the San Blas route, will give us an indication of the work before us in piercing a tunnel, and the homogeneity and stability of the material. Further than that, we cannot say. Nobody has bored into the heart of that mountain to determine just what may be its character and to what extent we may depend upon the uniformity and closeness of its structure. It may be, and the probabilities are, that the most of the rock found in that tunnel will be sufficiently homogeneous to be self-sustaining.

The general reputation of granitic rock for continuity and closeness is pretty well sustained by the fact that it usually excludes water infiltration. Of 2,000 metres of granitic gneiss, of a single stratification, in the St. Gothard tunnel, the work was quite dry.

But if, on the other hand, we admit the probability of finding demoralized rock, we know the proportion of it in the tunnels that have been excavated. Let us take at random the Hoosac tunnel, as the nearest and most prominent example. Mr. Shanly told me recently that they found various characters of rock there, some granitic rock, but largely mica schists and other schistose formations, and of 25,000 feet in length, which he excavated under his contract, only 4,000 feet needed any arching of masonry. Here you find a tunnel made with a very flat arch—a tunnel in a very variable climate, the temperature now up to 100, now down to zero and below, freezing the water in the crevices. Upon the isthmus we have a nearly uniform temperature of 70 to 85 and perhaps 90 degrees. There would be no snow—no freezing. The arch would be a gothic arch, as shown here in the figure. If we should find as great a proportion of the length of the tunnel that would need arching as they found in the Hoosac tunnel, which would be in this case a trifle more than one mile, it is proposed that an arch be constructed resting upon abutments in the natural rock sides of the tunnel, 50 feet on the curve of the arch below its crown, which would make each segment or rib of the arch a length of 50 feet. Now, to construct that arch with these ribs made of cast iron, would give about seventy-five per cent. more strength, with only about one-third of the dead weight of an arch made of the best of stone, as granite, five feet in thickness over that whole space. A section of one of those ribs may be roughly represented by a plain letter T, with the head stroke shortened and the body stroke lengthened. The width of the head, which would be on the greater or outward curve, next to the rock, would be one foot, and the depth of the remainder of the section of the rib would be two and one-half feet at the crown of the arch, and three and one-half feet where it rests upon the abutment. A shoe or bearing plate would be cast on either end, the full width of the head and depth of the section, the shoe, on the lower end, resting on the abutment, and the bearing-plate on the upper end coming in contact with that of its fellow at the crown. As these ribs would be placed close together, each successive pair in contact with the preceding, it will be seen that each foot in length of the portion of the tunnel arched in this way would be represented by a pair of these ribs. The metal in the ribs would be of a uniform thickness of two inches, with a fillet at the junction of the head with the body. But objectors will say that the iron will easily perish with rust, and so crumble away. Now, we know that iron rusts in proportion to its purity. Cast iron rusts very much more slowly than wrought iron, and wrought iron chemically pure rusts most freely of all. But these ribs or segments are so devised that neither a drill or a chisel will touch them; and by lining or sifting the mould with the elements of glass, or the powder of ground glass of the commonest description, you will cast upon those ribs a coat of glaze, so that they would be protected for an indefinite period of time from rust. These segments of the arching being placed close to each other, side by side, the backs of the whole, when in position, would represent a continuous arch-roof of iron, and the space between this roof and the irregular rock above, perhaps from three inches to a foot, would be filled with concrete. The arch thus constructed could be rapidly and easily put in position, and the cost would be less than one-half that of a granite arch of the thickness I have named. It would be very difficult to put up large granite blocks in an arch of that character, and it would involve a great deal of work, and be very slow of accomplishment. Such an arch of iron has therefore been proposed, if it should be found that an artificial arch would be necessary; and if so, our present examples teach us that it would only be required, in this tunnel, for about the length of a mile.

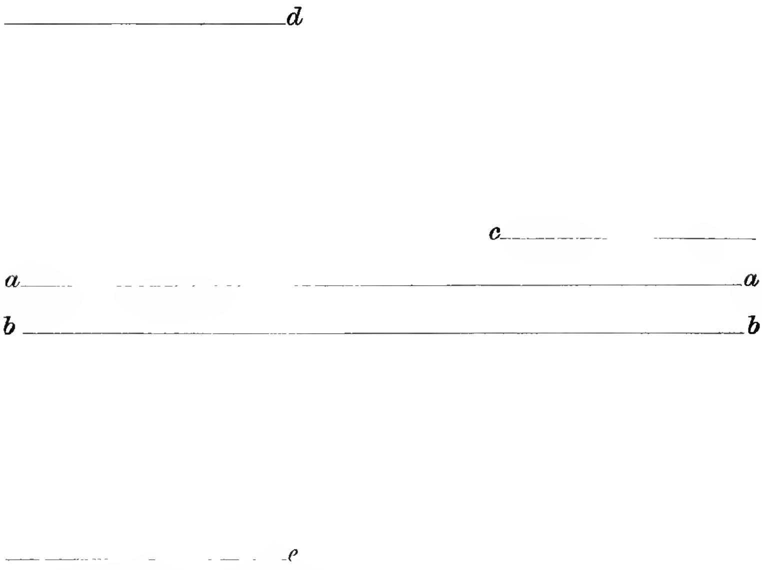
I believe I have spoken of all the points in the excavation of this tunnel, except this matter of infiltration. It will be seen that in the excavation of the preliminary tunnel, whose floor would be 175 feet of elevation above the sea, the drainage of the infiltration could be made perfect at each end; and only in case shafts are sunk from the top of the mountain to expedite the work, would pumping be needed, and then only in the shafts. While there are peaks of the Cordilleras which rise very high above the general plateau of the elevation, there may be points selected in this plateau where these shafts can be sunk at perhaps an average of 500 to 600 feet above the level of the sea; so that the shafts would be of that depth minus 175, the depth from the floor of the preliminary tunnel to the sea level, or altogether a depth of the shafts of from 325 to 425 feet. In the

Hoosac tunnel they pumped up the water of infiltration for the whole working central section through a shaft of 1,030 feet deep. They had shafts in the Sutro tunnel of 800 or 900 feet in depth—twice and three times the depth proposed here at San Blas. But, leaving out of view the question of the shafts, this preliminary tunnel can be perfectly drained from each end, while the work is in progress, without a gallon of pumping, and the drainage could be equally perfect while driving through the whole depth of the tunnel open cut work, until you get down to the level of the sea ; and then first, of all the work, would the water of infiltration need to be removed by pumping; but that would only be for the depth of the excavation below the level of the sea, varying from nothing to a depth of 28 feet.

Now, where you have a depth of 1,100 or 1,200 to 2,000 or 3,000 feet, from which to pump water, it is a different problem altogether from that where you have only to pump it up an ordinary depth of 28 feet. The large centrifugal pumps, now in common use, would throw almost a Niagara of water up from so small a depth into sluices which would carry it off. By excavating this portion of the tunnel in consecutive sections of half a mile, Mr. Shanley has stated, and I perfectly agree with him, that there would be no difficulty whatever, with ordinary pumps, in easily keeping the water free from this excavation while it is being made to the depth of 28 feet below the level of the sea.

Of course the excavation of the five miles of the canal between the tunnel and the harbor of Mandinga would be done in the lower portion next to the harbor by dredging machines, thus bringing the navigation up to within about two miles of the mouth of the tunnel, and this two miles being excavated down nearly to the sea level, a bulkhead of rock would be left towards the sea end of it, perhaps 20 feet thick, while the rest of it is being excavated below the sea. The same condition, as to open-cut work, drainage and pumping and method of procedure, would obtain upon the Pacific side as upon the Atlantic; a considerable portion of it would be done by dredging machines, commencing at the debouchement of the canal into the river Bayano.

Now, in regard to the tide levels of the two oceans, and in regard to the tide-lock that would be required for this canal. As I have said, the mean rise and fall of the tide in the harbor of Mandinga, upon the Atlantic side, is eight-tenths of a foot. Now, that being the mean, the extreme would be somewhere about two feet at spring tides, and with the wind blowing from a direction to pile up the water in the harbor, or the reverse. So that, in order to keep a depth of water in the canal of 28 feet at all times, without a gate or any artificial structure upon the Atlantic side, it would be necessary to make the level of the water in the canal to correspond with the lowest low water level in the Gulf of San Blas. The conditions of the whole case will be readily represented by some parallel lines shown on this diagram:



The line *a a* will represent the level of half-tide, which is the same in the two oceans. Of course, it is readily understood that if there were no tide in the Atlantic, and no tide in the Pacific, and the waters of the two oceans rested quietly without tidal movement the same as in a small lake or pond, they would be at the same general level in both oceans, due to the law of terrestrial gravity ; and that level would be the level of half-tide as things at present exist, and would be represented by the line *a a.* Although it is not the practice in popular usage, for the purposes of this illustration we will say, when the tide rises it is above *a a*, and when it falls it is below *a a*. Taking the distance between the lines *a* and *b* and between the lines *a* and *c* to be in each case one foot, *c* would represent the maximum rise of the tide and *b* the maximum fall of the tide at the Atlantic end of the canal; the mean rise of four-tenths of a foot above *a*, and the mean fall of four-tenths of a foot below *a*, coming of course between the lines *b* and *c*, it is not necessary for our purpose to represent. Now, instead of taking the half-tide level *a a* as the proposed level of the water in the canal, we take the line *b b* for that level ; because, if *a a* were taken as the level of the water in the canal, when the tide had fallen in the Gulf of San Blas to the line *b*, the water in the canal would run towards the gulf, for the water in the gulf would then be one foot lower then the assumed level of the canal. To avoid such a state of things, therefore, it is proposed to make the level of the water in the canal correspond with the level of lowest water in the Gulf of San Blas, that is, the line *b b*. On the Pacific side the mean rise and fall of the tide is 16 feet, that is, eight feet rise above the line *a*, which is represented by the line *d*, and eight feet of fall below the line *a*, which is represented by the line *e*. But the line *b* has been assumed as the level of the water in the canal, and therefore, in the ordinary movements of the tides on the Pacific, the tide-lock at that end of the canal would, a part of the time, lock upwards from *b* to *d*, a height of nine feet, and the remainder of the time lock downwards from *b* to *e*, a descent of seven feet, these conditions of lockage alternating as the tide should be high or low in the Pacific. At times, however, the tide rises and falls in the Pacific at this part of the coast more than 16 feet, in which case the lockage either way would be correspondingly increased.

The tide lock upon the Pacific end of this canal would be constructed of a length of 1,125 feet and a breadth of 100 feet ; the gates, instead of being double at either end of this lock, would be single, and would be sliding instead of folding gates, and move on rollers, the advanced end of the gate moving into a recess across the opening of the lock, so that the pressure from either side will not disturb it from its position as the tide may be high or low. These gates need not be tightly fitting, for, since the two oceans are the water supply, the escape of more or less water in the one direction or the other is of no consequence.

At the middle division of this lock there would be a slight contraction in its width, and here would be another gate of the same construction, which would ordinarily be left open. Now, you may conceive that occasion may arise for the removal of one of these gates for ordinary repairs; or one of them may become damaged by accident, in which case you always have a tide-lock between the other two, of a length of 560 feet, and either one of the three may at any time be regarded as an extra gate, and be removed for repairs. It will be observed, that a tide-lock as here proposed to be constructed and used, is not at all comparable with the detail lockage and conservation of water supply, as contemplated on the Nicaragua route. There the gates must be close fitting, to save their lockage supply, and double and mitreing to each other, that they may be close fitting, and the locks made as small as practicable, and locking only one vessel at a time, all for the purpose of saving the water. In our tide-lock, however, prodigality is not waste, for what escapes from the Pacific goes to the Atlantic, and *vice versa;* and, until both these oceans run dry, we shall always have enough. So that, in our tide-lock of the length and width proposed, six ships of 1,000 tons each can be passed through in one lockage.

To fill and deplete this tide-lock, it is proposed that the main gates shall have subsidiary gates arranged within them, to be raised or lowered, so as to open and close a passage through the main gates 60 feet wide by six feet high, located below the level of low water in the gate next to the Pacific, and at any convenient distance below the water in the canal at the opposite end of the lock. The time required to fill the entire undivided lock to a level of nine feet would be less than three minutes.

It hardly seems to me that the question of calms in the Bay of Panama needs any more explanation than I have already given it, both here and elsewhere. But I want to say that this subject has been investigated and reported upon, under the concurrent written instructions of Commander Selfridge and Admiral Ammen, then in the Navy Department, by Lieutenant Frederick Collins, who was attached to Selfridge's expedition, and who was ordered to inquire and report upon the winds and tides of the Pacific ocean, with particular reference to the functions of a canal constructed on the Atrato-Napipi route. This is the gallant Collins who, as we all know, never stood up against the flag of his country, nor forswore the oath which made him one of the trusted protectors of our constitutional Union and our civil liberties. In his investigations he had occasion to make some observations and pass some criticisms upon that other former officer of our Navy, Lieutenant Maury, and to point out a great discrepancy of view between the well-known authority, Kerhallet, and his own countryman with reference to the general subject of his inquiry. Now, Lieut. Maury had the whole Pacific ocean for the subject of his inquiry, away across to the China seas, and so did Lieut. Collins, and yet, while he was to make all the results of his work to converge on the edge of the Bay of Panama, at the Pacific end of the Atrato-Napipi route, he does not even once, with reference to calms, mention the Bay of Panama in his report. Was this gallant officer overawed in his judgment by the dominant officialism of a then different interest, or did he really forget to point out to his superior and directing officers the one important fact they should have known as against that route, if the objection of the calms which the Nicaragua advocates now spread with so much *wind* of talk over the whole Bay of Panama were really a valid one? But leaving them to their efforts, I have to say there are, generally speaking, up and down this Pacific coast of North and South America what are called coast trades, or, localized, the monsoons of Mexico. When the sun is going south these winds blow towards the south. They go with the sun. When the sun is coming north, they blow towards the north. It is 300 miles away to the westward from the general line of this coast that the great system of winds of the Pacific are located and extend across to the China seas. It is true there is located in the general system of the winds of the Pacific a belt across the Pacific near the equator, called the belt of the "doldrums," but this word does not mean calms by any interpetation, but rather light and variable winds, with storms of wind and rain and squalls and calms thrown in; or, as the sailors call it, "dusty weather." But what has this to do with the coast breezes, which by common report we are told exist in the tropics? And yet, if the logic of the objectors should hit the real fact, instead of an assumed one, it would prove too much; for a vessel going through a canal by the Nicaragua route, and destined to any of the ports of the South Pacific, Australia, New Zealand, the west coast of South America, and the numerous islands south of the equator, would have to pass, in the voyage, through that whole belt of "calms" which they use so diligently to give size to their statements when objections to any more southern route than their own are in place to be heard.

But they are careful to locate these "calms" precisely in the Bay of Panama. They say a vessel would be likely to be held in this region for perhaps three months, not able to get in, or once in, not able to get out. Surely, in their view, it must have been here where Coleridge's Ancient Mariner conceived the situation of a "painted ship on a painted ocean."

Now, I have the practical observations and experience of sea captains in the California trade, who have gone into the bay of Panama time and again. I have the statement of the President of the Maritime Association of the Port of New York, who sent the first vessel to California, with supplies in the early days of its *El Dorado*—whose firm in the height of this California trade sent as many as 125 to 130 vessels with various materials in a single year to Aspinwall and Panama, the one and the other, and that they regarded Panama as favorably for access and sailing convenience as any port on the coast. That, then, is the practical statement of the case.

Judge DALY : Are there any earthquake difficulties on the San Blas route, so far as known ?

Major SHELBOURNE : There are none, so far as we know, from the earliest records. We have, on the contrary, the geological character of this portion of the isthmus, and the notable fact that in all this region of the older rocks we have not a sign of a crater, living or dead. Of course I do not wish to be understood to mix up earthquakes and volcanoes as necessarily coexistent in the same localities; but, while earthquakes are due to the mighty pent-up forces under the crust of the earth out of their equilibrium, and seeking relief, the volcanoes are the local, the open and the speaking mouths of the earthquake energies.

Judge DALY: About how far does the volcanic rock come down upon the isthmus ?

Major SHELBOURNE: It comes down on the north to the Panama region; and, as I said, this portion of the isthmus, from Panama up to, and I know not how far beyond, Nicaragua, is entirely of a later formation—a secondary sedimentary, and a tertiary volcanic origin. There is also basaltic or volcanic rock in the San Blas region, but it forms the caps and the overcoat of the Cordillera, so to speak, while the bases of the mountain are granitic. As to the activity of earthquakes in the region towards Nicaragua, I was informed after the last meeting in this room, a week ago, by one of the gentlemen present—I think the one who spoke last, and was called upon by Mr. Menocal to give some idea of prices of excavation in Nicaragua, because he had been connected with engineering work in Costa Rica—that during the past year advices had been received that in one of the towns of Costa Rica, which, as you know, adjoins Nicaragua, a cathedral had been rent and very much damaged by an earthquake. Now, in the San Blas region of the isthmus, the region of the very earliest rock formation, as I have said, so many ages have elapsed since it was the scene of active volcanic energy, that nowhere are there any traces even of extinct craters to be found. But if you go either north or south, on the one hand only as far as Mexico, and on the other to the Colombian territory itself, at the very northwest part of the South American continent, we find regions of active volcanic action, an example of which may be found in the Colombian State of Tolima, where there is an active volcano identical in name with the State. In fact, geologists tell us that under the South American region of the Andes, from Colombia on the north to Chili or beyond on the south, there are whole lakes of melted lava, involving regions of hundreds of square miles in extent. It is a well established fact that earthquakes have their origin and are most frequent and violent in active volcanic regions. Now, the fact that from Panama south to the Gulf of Uraba no indications of even extinct craters exist, and nothing more than the very slightest sensations of earthquakes have been felt, and no damage done discoverable from the time of the earliest records, points sufficiently to the conclusion that active volcanic and subterranean action have entirely ceased in this part of the isthmus since remote ages. In like manner we find in other parts of the earth the same conditions to exist, for ancient volcanic mountains are met with in Hungary and in central France, of whose eruptions no record exists, and many parts of the Rocky mountains give evidence of the same character. Fisher's Peak in Arkansas is also said to be an extinct volcano. In 1863, the best authorities enumerated eighteen active volcanoes in Central America. As none of these are to be found in the Columbian part of the isthmus, they must be credited to the more northern countries, of which Nicaragua and Honduras are the central states. Within the past month a map has been published, the data of which is the work of Dr. Kuyper of Holland, giving the location of thirty-eight volcanoes between the southern bounds of Costa Rica and the proposed Tehuantepec route on the north, of which number ten are found in Nicaragua. It is not stated how many of these are active, and only the figures of 1863, which I have given, will enable you to form an opinion.

It seems, moreover, natural in science that in this narrow San Blas region of the isthmus, which was slowly upheaved ages and ages before the more northern region was produced, that volcanic action should be now entirely dead, and as to earthquakes having their origin in regions more or less remote, the pent-up forces under the crust of the earth seeking a vent would be found to demonstrate their energies, according to science, in the line of least resistance, instead of up through a narrow ridge of high mountains with deep ocean beds on either side. It would appear, therefore, from all the considerations adduced, that we are entitled to expect entire safety for a tunnel pierced through the San Blas Cordillera.

It has been suggested by some of the friends of this route that the canal ought not to be taken into the Bayano river at all, but to make a separate cut for it along the valley of the river into the bay of Panama, with the object of avoiding the continual filling up of the deepened river and bar at its mouth by the material brought down from its head waters. That is merely a question of choice based upon cost; the bottom of this river is largely mud and easily excavated. It would cost about five million dollars extra to cut the canal outside of the river and make a proper mouth for it in the bay. The interest on this sum at four per cent. would represent an annual sum of $200,000. For half this sum per annum the required depth in the six miles of the Bayano river could be constantly maintained.

Judge DALY: Can you give us some idea of the general cost before you conclude?

Major SHELBOURNE: I have estimated the exact cost of the tunnel, as near as may be, placing the liberal prices I have named upon it. The cost of the preliminary tunnel would amount to $4,928,000; the cost of the remaining or floor work in the tunnel, at $3 per cubic yard, comes to $62,183,145, making about $67,000,000, assuming the width to be 100 feet and the height 168 feet for the whole tunnel. In addition to the tunnel there would be 17 miles of open-cut excavation, about one-half of which being of very small elevation the cutting would be light. You will observe, from the fact that no borings have been made to determine the depth through the soil to the rock, and no survey of an actual location of this line having been made, the character and depth of the open cutting at every particular point cannot now be given; but a general estimate, coming within a fair approximation, can be attained. I should say that for four miles of this work a half million dollars per mile would be a liberal estimate; for five miles of the remainder one million dollars per mile, and for the last eight miles a million and a half per mile would cover the whole cost, making the open cut work, outside of the tunnel, amount to $19,000,000. If two million dollars are allowed for the tide-lock on the Pacific and for other minor works of artificial construction, there would still remain twelve million dollars for general administration and contingencies to bring the total cost of a canal on this route up to 100 million dollars.

Judge DALY: What was the estimated cost by way of Nicaragua?

Major SHELBOURNE: As estimated by Mr. Menocal, it was altogether, about $66,000,000. But that was by placing a very inadequate estimate upon the work. If the prices for two items alone—the open-cut rock excavation and the submarine rock excavation—are brought up to correspond with the prices I have placed for the San Blas route, his estimates would at once be increased by the large sum of $31,000,000; that is, by estimating 14,677,386 cubic yards of open-cut rock at $3 instead of $1.25 and $1.50, as he has it, and by estimating the submarine rock at $12.50 per cubic yard, instead of $5, the price he has assigned. Without considering any other under-estimates except these two, and adding his usual percentage for contingencies, the cost of the Nicaragua route would mount up to $104,421,790.

It will be seen that the San Blas route is free entirely from the troublesome question of a large surface drainage and intersecting rivers. Cut through at one level, from tide-water to tide-water, it takes only the parallel valleys of the little Mamoni, near its mouth, and the still smaller Vercalagua, on the Atlantic side.

For access, this route admits of ship navigation to within five miles of the mouth of the tunnel on the Atlantic side, at the very outset of the work, and within seven miles of the tunnel on the Pacific side—permitting the unloading of machinery from shipboard within easy distance of the main excavation.

The whole work, with the progress being made elsewhere in rock excavation, could be executed probably in six and certainly within eight years. The preliminary tunnel could be completed in four years; but, from the outset, the open-cut work could be in free progress, and the floor excavation downward from the preliminary tunnel could follow closely upon the advancing heading. While the exposure of the entire work on the Nicaragua route would limit the operations to the daytime, and the work be suspended for times at least during the wet season, from rains above and floods beneath, the tunnel excavation at San Blas could proceed the year round, both night and day. For this reason 21 millions of cubic yards of floor rock could be excavated under the roof of the San Blas tunnel in less running time than the 15 million cubic yards of exposed open-cut rock on the route through Nicaragua.

It remains only to speak of maintenance and cost of towage. The advocates of the Nicaragua scheme have assigned a sum of a million and a half to two million dollars per year for the maintenance and operation of a canal by that route. Its total length is more than six times as great as the route by San Blas, and because of its multitude of locks and other artificial constructions, and the fact that its promoters are not noted for excessive figures—if we take the larger sum as the approximate one, and reckon a pro rata expense for this natural, rock-walled passage at San Blas—there will be held of its income, each year, an advantage over the Nicaragua route of more than a million and a half to the credit of its dividends.

And we mark the towage at the same proportion—five dollars of every six saved to the vessel, or, with no difference to its owner, added to the profits of the scheme. Would you not say that in these last items alone it would be easy to determine a balance of reasons sufficient to move the money circles of the world to the route they should choose?

I have thus presented the most important features of construction and advantage of the shortest of all possible routes through the isthmus, and I have long had the conviction that it will eventually share alike the earnest attention and favor of men of science and capital and commerce.

Judge Daly spoke of the address of Major Shelbourne as being a clear, precise and practical exposition of the subject, founded upon facts and free from speculation—a communication of great importance.—The meeting then adjourned.

THE INTEROCEANIC SHIP CANAL.

Special Meeting of the American Geographical Society, held at its rooms, No. 11 West 29th Street, New York, on the evening of Monday, December 29, 1879.

There were present—Chief Justice Daly, Mr. Frederick M. Kelley, Mr. H. H. Hall, Mr. John E. Body, Major S. F. Shelbourne, Colonel D. Woodruff, U. S. A., Elial F. Hall, Henry Morrison, Jess Young, Dr. St. John of Cleveland, Ohio, General G. W. Cullum, U. S. A., Alexander Lang, Chief Justice Curtis, General Egbert L. Viele, Mr. N. P. Bailey, Captain Jenkyns C. Battersby and Mr. Octave Chanute.

Judge DALY, the President of the Society, upon calling the meeting to order, said that the last evening had been devoted exclusively to the consideration of the San Blas route ; but that the desire of the Society was that all the routes should be investigated, so far as was possible ; that it was proposed to listen this evening to Mr. Hall in an exposition of the Tehuantepec route, which had been surveyed for a railroad, and to a certain degree for the purposes of a canal. Judge Daly said he understood that measures were now being taken to build a railroad, without reference to the building of a canal, and that it was a matter of interest to know how far, for the present and for the future, a railroad would serve the general purposes of commerce, and to what extent it might dispense with the necessity for a canal ; but that the general impression prevailed in this country, and throughout the commercial world, that a canal will ultimately be necessary. After alluding to the favorable geographical proximity of the proposed route to the United States, and particularly to their southern boundaries, Judge Daly introduced Mr. H. H. Hall.

Before making his remarks upon the Tehuantepec route, Mr. Hall read the following communications:

> Your attention is called to the accompanying copy of a railway grant across the Isthmus of Tehuantepec, and also to the epitomized memoranda.
>
> The grant gives authority to Edward Learned and his associates to construct

a railroad and telegraph across the Isthmus of Tehuantepec, and operate the same, for the term of ninety-nine years; and, in aid of such purpose, donates large subsidies both of land and money.

The eastern or Atlantic terminus of the road will be at the mouth of the Coatzacoalcos river, about one hundred and ten miles southeasterly from Vera Cruz; the line will run thence southwestwardly across the plains to the mountain range; thence across through the range to Chivela pass, and thence across the plains to the inland lake called the Upper Lagoon, on the Pacific coast. The length of the main line will be between 140 and 150 miles. Turnouts and sidings may make the extreme length 160 miles.

The road will traverse an exceedingly healthful and productive country, with easy grades, and, for the most part, requiring comparatively inexpensive preparation for the superstructure. The mountain section, with a summit altitude of not exceeding 750 feet, presents no unusual or serious obstacles, and can also be prepared without very extraordinary cost.

Harbors, safe, commodious and easy of access by the largest class of vessels, will be constructed at the mouth of the Goatzacoalcos by deepening the present channel over the bar for a distance of 600 feet, and at the Lagoon by dredging an entrance channel from the Pacific across the intervening sand bars a distance of two miles; by an alternative arrangement, which would somewhat increase the length of the road, this dredging may be materially reduced. At each terminus will be constructed desirable facilities for receiving and discharging cargoes direct to and from the cars, to and from the ships alongside of wharves, whereby an immense business which is now forced around Cape Horn will be drawn to the route. The tolls provided by the grant to be collected for the use of these harbors will rapidly repay their entire cost, and at an early day their entire amount will become net revenue to the road.

The Atlantic terminus will be:

665 miles south from Galveston.
725 miles west-southwest from Havana.
800 miles southwest from New Orleans.
1,905 miles from New York.
2,076 miles from San Francisco.

The route from New York to San Francisco will be about 1,500 *miles shorter than by the Panama line*, and when the contemplated canal across the peninsula of Florida is constructed, this advantage will be largely increased. The route will materially shorten all lines of communication, and facilitate the transmission of traffic between the principal ports of the Atlantic and Pacific oceans, and consequently will attract to it that portion of the trade of California, Oregon, China, Japan, Australia, New Zealand, Manilla, Batavia and the numerous fertile islands of the Pacific, which under these advantages can afford the expense of the Isthmus transit.

The gross tonnage, inward and outward, to and from those localities in 1878, exceeded 2,500,000 tons, wool, wheat, sugar and tea being the most prominent. Australian wool by this route can be delivered in England in 50 or 55 days, giving an advantage in time of from 50 to 75 days; and California wheat can be so delivered in 50 days, with a time advantage of from 70 to 90 days, and an avoidance of the damage (estimated at 15 per cent.) of twice crossing the equator. Ordinary drafts against shipments by this route may be provided for by sales and actual delivery before maturity.

As a passenger route, the line will offer the inducements of favorable latitude, salubrious climate, direct transit and shortness of sea voyage, with freedom from extremes of heat or cold, blockades of snow, and the vicissitudes of navigation around Cape Horn.

In addition to the eight lines of steamships which now ply to the Gulf of Mexico, new lines will be established on both the Atlantic and Pacific, to meet the requirements of the new course of trade created by this route.

In estimating the probable revenue of the road, it is regarded that despatch, safety and prompt delivery will control the direction of such of the foregoing traffic as is not forced into other channels from economic considerations, and that it is certainly not extravagant to assume that at least thirty per cent. of the above gross tonnage will be transported over this route.

REVENUE.

30 per cent. of 2,500,000 tons, 750,000, at $5 per ton, railroad tariff		$3,750,000
15,000 through passengers, $10 each		150,000
15,000 tons local freight, $5 per ton		75,000
15,000 local passengers, $4		60,000
Tonnage dues, tolls and all other revenue		350,000
Gross earnings		$4,385,000
Deduct for operating expenses, repairs and depreciations, 50 per cent., although with such high tariff 40 will be ample		2,192,500
		$2,192,500
Deduct for allowance to Mexican Government on 15,000 through passengers, 12 cents each	$1,800	
On 750,000 tons through freight, at 25 cents per ton	187,500	
		189,300
Net income		$2,003,200

COST.

In estimating the cost of the road, harbors and appurtenances, it is to be borne in mind that the route is by no means a *terra incognita*—elaborate surveys, maps and profiles have been made under the auspices of the government, one for railway by Gen. J. G. Barnard, U. S. Engineers, another by Gen. W. H. Sidell, U. S. A., and for a ship canal by Capt. R. W. Shufeldt, U. S. Navy, supplementing a survey by Señor Moro. All authorities agree as to the practicabilty and feasibility of the road, the favorable character of the country, and the permanency of the harbors; furthermore, that all foreign material for construction will be imported free of duty; and that the road will be constructed at its lowest money cost without intervention of "construction companies" or other devices, which not unfrequently divert into irregular channels the money of investors.

ESTIMATE.

For clearing, grading and masonry, 130 miles, at $7,500	$975,000
20 miles mountain section, at $25,000 per mile	500,000
Iron Bridges	200,000
160 miles ties and track laying, at $2,750 per mile, including 10 miles siding	440,000
160 miles, including siding, steel rails, 1,500 tons, at $32 per ton	480,000
550 tons fish plates and spikes, at $50 per ton	27,500
Stations, machine shops, tools and fixtures	300,000
Rolling stock	600,000
Harbors, wharves, &c., Atlantic terminus	250,000
" " Pacific "	750,000
Freight, haulage, &c	50,000
Engineering	300,000
Contingencies, 10 per cent	487,250
	$5,359,750

The above estimate is believed to be considerably in excess of the actual amount necessary to open the road, well supplied with all requisite appurtenances to perform its business.

NEW YORK, December 27, 1879.

EDWARD LEARNED, *President, &c.*

SIR,—In regard to your request that we shall give you our professional opinion as to the "feasibility, cost and advantages of the Tehuantepec Interoceanic Railroad, equipped for a business, say, of 750,000 tons per annum, and also of the practicability of establishing good harbors for vessels of 25 feet draft at each terminus, with the probable expense thereof," we have to say:

That from our examinations of the very complete maps, data and statistics furnished by the several governmental and corporate surveys heretofore made, and from other sources of information to which we have had access, including a personal examination of the line several years ago by one of the undersigned, Mr. Van Brocklin, we are enabled to give with great confidence the opinion that the railroad can be substantially built with steel rails and equipped to the extent necessary for the amount of business named, for from four and a half to five millions of dollars, and that safe and adequate harbors can be established at each terminus, by an expenditure in the improvement of the entrances thereto, to admit vessels of 25 feet draft, for about a million of dollars.

That the work can all be accomplished within less than three years.

In regard to the advantages of the route, though not strictly a professional matter, we hold the opinion that from New York via Pensacola and Tehuantepec, San Francisco can be reached in eleven or twelve days.

That via Galveston and via the Missouri, Kansas & Texas Railroad, East India goods, sugar, teas, &c., can be laid down in St. Louis, and probably in Chicago, more cheaply than by any overland all-rail route.

That freight from the Atlantic ports can be delivered in San Francisco in about fifteen days.

That the vast grain crops of Oregon and California will seek European markets by the Tehuantepec route from either of the several advantages it will present over the route via Cape Horn. As we proceed to-day to Mexico, we hope in a short time to supplement this statement by facts from personal observation, which will more conclusively determine the professional opinions herein given.

Respectfully,

[Signed] WM. J. MCALPINE,
Consulting Engineer.

[Signed] M. VAN BROCKLIN,
Chief Engineer.

Mr. HALL then began his remarks, frequently referring to a map of the district. He said :

This important route commences at the Coatzacoalcos river. We propose ending the line at the lagoon or lake upon the Pacific side. The city of Tehuantepec is situated inland about eight miles from the Pacific coast. The greatest height that we have to surmount is about 760 feet, at Chivela. We have to cut a canal from the Pacific into the lagoon, about 2½ miles. That is cut through a sandbar, which was formerly part of the sea, but which has been formed from the wash from the Tehuantepec river and from other rivers emptying near there. The lake is about 12 miles wide and about 16 miles in length, having an average depth of from 19 to 21 feet, with about four feet of rise and fall of tide. The cutting will give a harbor with 25 feet of water at high tide. On the Gulf side, I found in the survey that we had about 1,200 feet from the line of the coast, a bar of about 400 feet, where we have now about 15 feet of water. That we have, of course, to cut away, and after dredging through this bar we have about eight miles from the coast line on this river, carrying about 38 feet of water.

The line of the route will take this direction [following Rio Nueva], coming off to the westward, coming down through here [on Farifa plains] and passing down through Chivela. At the pass on this highest point we have mountains on each side rising from 8,000 to 12,000 feet. Chivela pass, itself, is only about 26 miles in width, reckoning from the mountains where we come down to the Pacific plains, where is a very beautiful, level and fertile country.

In speaking of Tehuantepec, I want the Society to understand that I am not here to disparage the canals or anything of that kind

—far from it. I would like to see the canal go through the Isthmus of Tehuantepec. The railway will go a long way to assist this enterprise. I have crossed the Nicaragua route. My impression is, a canal never will be built there. On the Nicaragua route we have to traverse a river, and my impressions are that for some 80 or 90 miles it will be almost impossible to dredge or to keep up banks. On the Tehuantepec line you have got, you will notice, this river running up to the edge of these mountains ; you carry a river there for about 90 miles, and then you have this summit to overcome. Speaking of tunneling and cutting deep cuts, my impression is that you can get a canal through Tehuantepec with nearly the same cost as on the Nicaragua route. I maintain that the point of health is one of the main things in carrying through an enterprise of this kind. Then, again, there is no comparison between the two regions of country. It is also much nearer our own shores. At this point [Coatzacoalcos] we have easy navigation for Galveston, Pensacola, New Orleans, from there on to Havana, and, you may say, nearly home. There is no trouble from earthquakes on the Isthmus of Tehuantepec ; earthquakes have not been known there for many years.

I have been some 25 years connected with the Pacific trade, having resided 24 years in Australia, and established the very first Australian mail service to the United States. I took that up single-handed, and opened the service between Sidney and San Francisco, a distance of 7,260 miles—to-day, I think, the longest mail route in operation. My attention was first drawn to Tehuantepec by noticing the straight line that we had from Australia to Europe. Then, from China, the passing through this isthmus gives us another very favorable position. There are many features worth mentioning. After many years' experience, I found that the trade of the Pacific required a different class of ships from those in use upon the Atlantic. The Pacific trade requires light ships, well ventilated, with large carrying capacity. In the Atlantic we know that very heavy ships are required, with very large tonnage, and great speed and good sea qualities. I have been for many years trying to connect with the Union and Central Pacific railroads for the purpose of getting through freights for passengers, specie and different commodities, and have been unable to do it. From San Francisco to New York alone they would have to traverse about

3,200 miles by rail. Of course, to get freight through that length of road becomes expensive. On the Tehuantepec route, it being only 140 miles in length and on a straight line, we would control the better portion of a very large trade between the United States and the Australias; and not only that, but with the Pacific islands. When the Australian service was first started we called at Kandavan, one of the Fiji group; thence went to Honolulu. The trade, at the beginning, on the round voyage to those different islands, would amount to $6,000 or $7,000 ; and we thought that was very good work. To-day that service is paying $30,000 to $40,000, over that same track, stopping at the three points. My round voyages then used to work in about $30,000 ; to-day they are netting about $80,000. That simply shows, by steam communication touching at these different points, even from San Francisco to the Australias, what the service will be. We took in coal at Sidney to supply our ships from New South Wales to San Francisco and back. That also shows the advantages to-day gained by the compound engine. In former days, to do that service, which was really 15,000 miles, would have taken over 5,000 tons of coal; now about 2,500. The service from Sidney to Panama was undertaken by the Panama Steamship Company, but that service failed on account of the heavy consumption of coal and the great distance that they had to steam with no coaling stations.

Judge DALY : The report states that the distance from New York to San Francisco by way of Tehuantepec, would be about 1,500 miles less than by way of Panama. Is that correct ?

Mr. HALL : It would be about 1,300 miles.

Judge DALY : Will you state what the route would be—the sailing route—the shortest distance ?

Mr. HALL : The distance from New York to Panama would be about the same that it would be from New York to Tehuantepec, or rather to Coatzacoalcos; the difference is really on the Pacific side.

Judge DALY: Allow me to ask another question. What would be the advantages over the Suez canal, for a route to India, by Tehuantepec or any of those routes ?

Mr. HALL : I don't think there would be any. For New York, it would be shorter. In coming from China to New York, it would be shorter by way of Tehuantepec than through the Suez canal, thence down the Mediterranean and across the Atlantic. I should say there would be a difference of 1,800 miles in our favor.

Judge Daly: It would make no difference to Europe?

Mr. Hall: No, I think it would not have any effect.

Judge Daly: Nor any canal through the Isthmus of Darien?

Mr. Hall: Well, there are some points where it would, and others where it would not, on account of winds. On the Pacific side, north of the equator, the strength of the northeast trades would be in latitude 16°; and, similarly, latitude 16° south would be the parallel of the southeast trades. So that, really, in coming from the Pacific islands in that direction, we get a fair wind running for the Gulf of Tehuantepec. Now, in making the Nicaragua route, when we get in about 12° north we are getting so far south again that we are running away from the parallel of trades and getting into the calm belt. When on this coast, it is almost impossible to handle a ship under sail; you have to depend upon steam, on account of calms. Panama, I suppose, would be about 8° north. Then you have to go a good distance southward from that before you get into strong winds.

Judge Daly: There is a belt of calms all along on either side?

Mr. Hall: Yes. That is the difficulty you have here, unless you work by steam. I think that a canal cut across by the Nicaragua or Panama route would only be used by steam—that it would be almost useless for sailing vessels. You could not come out in the Pacific 1,200 or 1,400 miles to seaward to pick up a ship. No doubt, when she came on the coast line, there would be steam tugs to carry her through. Most of the trade coming into the lagoon would be from the northward—from China and other northern countries landing their cargoes there, and then passing over instead of coming on the long route around Cape Horn.

When I took up the Australian service, my object was the running of the mails from Australia to Europe. We had a large subsidy for the purpose. We are performing that service now in 42 days, touching at Honolulu, San Francisco and to Liverpool. I am under the strong belief that that service can be performed after the completion of the Tehuantepec route in 32 days. It is a long distance but with the experience that I have had in the Pacific, and with the known speed of ships, I am confident that this service can be performed in the time named. Of course these canals when completed will have some advantages; there is a large trade to be developed in the Pacific islands. We are now at work on the Tehuantepec road, having a staff of engineers, and I suppose between 200 and 300 men at the mouth of the Coatzacoalcas river. We are now working at that point. Mr. McAlpine and Mr. Van Brocklin sailed on Friday; they are on their way to the isthmus. The purpose of their visit is to make themselves thoroughly familiar with the Tehuantepec route; and if Mr. McAlpine's health permits, when he reaches Mexico I rather think he will visit the Pacific coast; and I hope that when he comes back he will be able to give you information that I have not.

In response to several inquiries, Mr. Hall said that on the Tehuantepec route a tunnel of about 12 miles would be required, with about 22 locks, through an easy country, with principally limestone formation; that the tunnel would come out about 60 feet above the lagoon, making a fall to that extent necessary before entering the lagoon; that the water supply would begin with a source that emptied into the upper end of the Coatzacoalcos river. In relation to the cost of the canal, Mr. Hall said that Mr. Garay, who was here some time ago, appointed to represent the Mexican government at the Paris Congress, estimated the expense at about $60,000,000. But Mr. Hall thought that was an estimate wide of the mark where a tunnel of such length and magnitude was to be cut. But where Mr. Garay's estimate was for 80 locks to the summit, and then down, this tunnel would require only 22 locks. After coming through upon the Pacific side, the tunnel would be 56 or 60 feet above the sea; and then it would come down on to what is called the Pacific plain. Mr. Hall was not able to say how high the body of the canal would be above the ocean. As a harbor, the mouth of the river on the Atlantic side is about 1,500 feet wide. A bar is there which must be removed; but from surveys it would appear that the sand there has not varied or shifted for the last 30 years. The tunnel would not be an open cut, but a regular tunnel, principally through limestone. There would be about 20 locks in all—10 on the Pacific side and 10 on the Atlantic. Mr. Hall said, that from advices by the last mail from Mexico, it was his information that the Mexican government had sent engineers to make a thorough survey, and regular reports for the canal, and he believed a communication on behalf of the Mexican government was to be presented to our government, asking the United States to withhold support until this survey could be made.

In reply to a question by Judge Daly, Mr. Hall said that he thought it would be found very difficult to compete with the Suez canal for the Indian trade. The Suez canal has a peculiar advantage in having no locks. Vessels generally anchor over night at the mouth of the canal ; at daylight they enter the canal, and about sunset of the next day they are through ; they always use steam power. Upon the Tehuantepec route, with the number of locks that would be necessary and the stoppages, Mr. Hall thought that it would take three days, or in that neighborhood, to pass a vessel 360 or 370 feet in length; but he thought for trade from Calcutta and China, there would be a gain for American ports of from six to eight days, and therefore great advantage would accrue to the United States; but for Europe he did not think it would be much used, except it might be for the west coast trade.

Major Sherbourne inquired whether, for the numerous islands in the South Pacific, a canal by the American isthmus would not be much nearer.

Mr. Hall thought that for the Australian, New Zealand, Tahite, the Feegee group and the Sandwich islands trade, it would be nearer for Europe to avail itself of the American isthmus for steamers, but sailing vessels would not attempt it; they would go round Cape Horn in preference.

An inquiry was made as to whether steam was not rapidly superseding sailing vessels.

Mr. Hall replied, not in all kinds of trade ; many classes of freight could be carried cheaper by sail ; although it was true that the use of steam was on the increase. But there was much time lost in collecting freights among the Pacific islands, and the expense of working a sailing ship would not be one-half that of handling a steamer of the same tonnage.

Major Shelbourne inquired whether, in laying out a line between Australia and Europe directly through Tehuantepec, Mr. Hall had considered whether it was equivalent to great circle sailing.

Mr. Hall replied, Yes; that the plan which he exhibited was on Mercator's projection ; that it had been furnished by the British Admiralty for the Australian service some years ago.

Mr. Chanute inquired which would be the short line from Great Britain to the eastern ports of China.

Mr. Hall said that he would go through the Suez canal—that it would be considerably shorter in positive sailing distance.

In response to an interrogatory, Mr. Hall said that he thought very few sailing vessels go through the Suez canal; that there were some transport-ships that went through by the aid of tugs; that the strong winds are not met until some distance below Aden.

In response to a suggestion, Mr. Hall said, that if a canal were cut across Florida a great deal would be saved in sailing distance and in insurance—a saving of at least 200 miles between Tehuantepec and New York; that it was proposed as a quick line to run from the Coatzacoalcos river to Pensacola, and then take an air line from there to New York.

Judge DALY: As I understand, you navigate the Coatzacoalcos river to a certain extent, and then your line begins.

Mr. HALL: No; we have abandoned that. It was first recommended to run up 22 miles from the mouth. That was General Barnard's plan, but it has been abandoned. We start directly from the mouth of the Coatzacoalcos river and have a railroad the whole way. The entire distance would be 150 miles from the mouth of the Coatzacoalcos river to where we end at the lagoon.

It was inquired whether there were any mountain torrents to interfere seriously with the road.

Mr. HALL: We keep on the dividing range. When we start from the mouth of the Coatzacoalcos river we run on nearly a level for 14 miles. Then we strike the dividing range, and we keep on this divide until we get to Chivela. We avoid all mountain torrents. The first survey that was made followed the level of the Coatzacoalcos river, but we find that a better plan is to keep away from the currents, although the distance is a little further. In a direct line it would be about 130 miles, so that we lose about 10 to 20 miles. For the first 30 miles we will have to send our ties from Florida; but for the rest of the distance we can get very good timber for the purpose. The principal timber on the isthmus is mahogany. The ties we get from Florida are hewn and of pitch pine. The Vera Cruz and Mexican Railway have been getting lately many of their ties from Cedar Keys and Pensacola.

Mr. Hall remarked, in conclusion, that this railway was quite interesting; that it runs a distance of 14 miles on a grade of 212.

Judge Daly then introduced Mr. John E. Body.

Mr. BODY prefaced his remarks upon the main subject of the evening by narrating an interview a few years ago between himself and Lord Kimberley, Secretary for the Colonial Department at London, formerly known as Mr. Wodehouse, Under Secretary of State. Speaking of the opposition of Lord Palmerston to the building of the Suez canal, the Secretary remarked that the opposition was confined to Lord Palmerston, who, in this respect, was not supported by the rest of the cabinet; that it was a part of the method of the British system to have as few fixed points of necessary agreement among the members of the government as possible, and while all were generally agreed upon general subjects, there were many matters upon which each member held and expressed ideas peculiarly his own. Lord Kimberley was exceedingly sanguine about the Nicaragua canal across the American isthmus, and thought it was bound to be built. Being asked by Mr. Body if he knew of any reason, political, military, or otherwise, that would make the building of a canal by way of Nicaragua objectionable to the British government, he replied that he knew of none whatever. He said that Great Britain considered herself at the head of the industry of the world, and that whatever shortens time or distance is in favor of the industrious nations. Being informed that the government of the United States was about to make surveys of the different routes which had been projected for the forming of a line of communication between the Atlantic and Pacific oceans, he suggested that, in the matter of the sending of a surveyor by the British government to accompany such expeditions, Mr. Body should see Earl Granville. Earl Granville thought, as the survey would be so purely American, while wishing it every success, it would be more appropriate for Mr. John Fowler, an eminent engineer of London, to send one of his surveyors rather than that the government should send a directly accredited representative. That it made no difference to the English government whether the canal was built by Englishmen, Frenchmen, Germans or Americans, so long as it was built, it being purely for commercial purposes, and let him do the work who can do it best and cheapest. Earl Granville said that the opposition of Lord Palmerston to the Suez canal caused a great deal of French money to be invested in it; it was thought by the French that the canal would be a serious blow to English commerce; that the trade of England with the East would be cut in two, and that France would be a great gainer. Earl Granville corroborated Lord Kimberley's statement that the attitude of Lord Palmerston with reference to the Suez canal was wholly individual, and confined to himself.

Mr. Body stated that he was President of the Central American Transit Company, who were the successors of the Atlantic and Pacific Ship Canal Company, the original grantees by the government of Nicaragua for a canal, and that eminent counsel had advised that the successors of the Atlantic and Pacific Ship Canal Company had the right as such successors to build the canal. Mr. Body also said that he had been connected with the Nicaragua route since 1850, and said that the greater part of his business life had been passed in watching the isthmus, and trying to forward the views of the company that he represented.

Mr. Body then spoke upon the topic of the evening as follows:

The range of mountains extending from 95° W. 17′ N. to 76° W. 4′ N., a distance of about 1,700 miles, including the Tehuantepec and Darien isthmus, forms one single chain in its entire length, and of such altitude that the navigator, having their summits constantly in view at a distance of 100 miles, can run his course by their direction. They screen the Pacific ocean from northers, except at Tehuantepec, where the depression of the chain in a north and south direction admits those furious winds to a limited action on that otherwise still sea.

The adjacent republic of Guatemala presents no such depression in her mountains. Nor do San Salvador or Honduras invite the passage of northers. These states, as well as the republic of Costa Rica, may be called mountainous regions having in their altitudes vast plains, fertile in all that the heart of man can desire, with a very salubrious climate; this is especially the case in Nicaragua, which is celebrated for its productions of coffee, sugar, indigo, cocoa (the finest in the world), cattle, and all kinds of fruits; hides, deer-skins, india-rubber, and an abundance of medicinal roots and plants; gold and silver mines, many of them of great antiquity and considerable richness.

Nicaragua is an old settled country, with a high civilization in its capital cities, and a widespread common school education all over the land. It is rare to find a man who cannot read and write, even in the lowest grade of laborers. The upper classes are just as well educated as we are, and fall in no degree short of our standard in the refinements of society; they are eminently a polite and hospitable people.

Nicaragua, like all the tropical countries of Central America, is short of population, and cannot be relied on to furnish the labor to build the canal, except very partially. We must look to China and the West Indies for working hands; but Nicaragua offers abundant and very cheap meat, fish, corn and fruits along the entire line of the proposed canal.

Moreover, there is no danger of having to fight hostile Indians in prosecuting the work; none exist upon the soil of the republic.

The geographical arrangement of Nicaragua differs from that of all the states in the range from Tehuantepec to Darien. *Nicaragua has two ranges of mountains running nearly parallel to each other:* the eastern range, which joins the mountains of Honduras, and is separated from the mountains of Costa Rica by the valley of the San Juan river; the western range, which begins with the mountain El Viego, 6,500 feet high, and runs a southeast course along and near the Pacific coast until it joins the mountain range in Costa Rica, which continues its southeast direction until it is merged into the great South American Andes.

In the departments of Metagalpa and Chontales, the eastern range of mountains discharge about one-half their water into the basins of Lake Managua and Lake Nicaragua. These two lakes are connected, and the outflow from Managua into Nicaragua lake is very considerable at high-water season, but it has never been gauged; at low water they do not connect.

In Lake Nicaragua, near its southwestern extremity, immediately opposite the entrance to the projected canal, which it protects from easterly or trade winds which prevail, is the island of Omotepec, about eleven miles long, having a remarkable mountain upon it, 6,500 feet high, almost a perfect cone in form. This remarkable mountain towers above everything surrounding, and is visible to the eye, and forms the true bearing for approaching the shore to ships, more than 100 miles out at sea.

In the Pacific or western range of mountains, in the immediate neighborhood of this giant sentinel, is found the lowest elevation in the mountain range, which separates the waters which flow into the Atlantic from those which fall into the Pacific, from the Arctic ocean to Cape Horn.

These facts are of such paramount importance that their discovery could not fail to interest the scientific world and to prompt men of enterprise to endeavor to acquire a geographical position which, in my humble judgment, has not its equal on the face of the globe.

Here let me fulfill a duty, which has been inexcusably neglected of late, to the memory of a truly great man, who was formerly state engineer of the state of New York—the late Orville W. Childs. Of his report on the interoceanic canal via Nicaragua, which I had the honor to submit to Mr. John Fowler of London, that eminent engineer said to me: "It fulfills all the requirements of modern engineering. I have read it with much pleasure on my journey from London to Scotland and back, and you may say that I endorse all that Mr. Childs has said in his report."

The various expeditions sent out by our government to survey the different routes which were proposed for the canal were all furnished with the report and maps of Mr. Childs.

It would be presumptuous in me to say that the opinions of Mr. Childs, formed in 1850 and 1851, must rule now. The recent surveys have been in very able hands, and have led to the discovery of economic facts of greater or less importance, more especially as the canal now is to have a depth of 28 feet instead of 17 feet, as laid out by Childs in 1850 and 1851; yet the main features of the canal route remain the same.

It was this very canal across Nicaragua, of which we hold the franchise from that republic, which called forth the Treaty of Protection, which, speaking in the name of modern civilization, says that they who do the work shall be protected in its possession—their capital shall be secure, and they shall enjoy the benefit of the enterprise.

In contemplation of the fact that Great Britain and the United States entered into a convention on the subject of this canal, I may be excused from noticing the unworthy insinuation that the work is a sentimental project.

Acting under very liberal instructions from Mr. Cornelius Vanderbilt and his associates, to determine the best line for an interoceanic canal, a survey was made and embodied in a report of the cost of constructing the interoceanic ship canal from the harbor of San Juan del Norté or Greytown on the Atlantic, to the harbor of Brito, on the Pacific, in the republic of Nicaragua, Central America, made to and for the American Atlantic and Pacific Ship Canal Company, in the years 1850 and 1851, by Orville W. Childs, chief engineer. The report embraced also a topographical description of the country, a thorough reconnoissance for a line from Salinas bay, on the Pacific, to the Rio Sapoa, an affluent of Lake Nicaragua; also, a line to the north of Rivas, which, after investigation, was deemed impracticable and was abandoned in favor of a line to the south of Rivas city, in the department of that name, from Lake Nicaragua to Brito harbor, using the Rio Lajas, which falls into Lake Nicaragua, and also the Rio Grande, which falls into the Pacific at Brito. The summit level between these rivers is only 46 feet above high water in Lake Nicaragua, and has a width of only 1½ miles; it is approached on each side up a generally broad and uniform plane.

The level of Nicaragua lake at high water is 103 feet above high water on the Pacific, and 111½ feet above the lowest tide level. The fall to the Atlantic is 107½ feet to the level of high water, and 108¾ to the level of low water, in San Juan del Norte, or Greytown harbor. The distance over which this fall is distributed is 119 miles of good navigable water, when the river is only half full. The pre-eminent advantage of the Nicaragua route for an interoceanic canal is the inexhaustible supply of water at the summit level. The great lake of Nicaragua has an average length of about 110 miles by an average breadth of about 25 miles, and receives the rainfall of more than 200 miles by 50. It is the great reservoir of water of Central America, which unquestionable fact marks it as the natural line for an interoceanic canal.

Colonel Childs estimates the quantity of water to supply canal navigation from the summit level, including evaporation, infiltration and leakage to locks, at a 105,130 cubic feet per minute, and the same eminent authority shows, by the test of its gauges, that the average outflow of the lake is 899,000 cubic feet per minute.

These tests were made from the 23d of December, 1850, to the 27th of April, 1851. They began when the lake was 3½ feet above low level, or about the middle stage, and they give the result that in that period of 125 days the supply from the lake was 143,022,600,000 cubic feet in excess of the requirements for the canal and its navigation, to pass three ships through its locks every hour. The great rise of water caused by the autumn rains had about half run off when the test of Colonel Childs was made. A rise of water in the lake of five feet only is a low supply. It is frequently six feet and upwards, and upon the area of this inland sea the increased volume in excess of low-water stage may be roundly stated at 400,000,000,000 cubic feet, without estimating the immense quantity which has to run out of the lake during the time when the rise of water is going on.

The rainfall, which is among the heaviest in the known world, having been gauged repeatedly, is found to give 98 inches for a year, or a fall of solid water eight feet deep, over an area four times the surface extent of Lake Nicaragua itself.

In consequence of the immense area of this lake, the water rarely rises over one or two inches a day, and its outflow by the San Juan river is regulated accordingly. In an experience of 25 years, there has not been a time when, on account of the rapidity of the current, the San Juan river, up or down stream, has been impassable, or even difficult, to steamers capable of making six miles an hour. It is during the season of the heaviest rains and high water on the lake and river that our steamers for the lake service have been sent down to Greytown, thence up the river to stations on the lake; this could not be done on any other river of Central America.

I believe myself justified in saying that no conditions exist on this continent so favorable to the construction of an interoceanic canal as are offered by Nicaragua, and this opinion I hold in common with very many men distinguished in science, whose views are on public record. The report of Colonel Childs fixed attention to this project and culminated in forming an American company to construct the canal. Of the report itself, I desire to say that it remains unchallenged after nearly twenty years of public exposition, and has received the approval of the engineer specially appointed by the British government to examine it; as also of our own board of topographical engineers at Washington, to whom it was referred by the President of the United States, in 1852. They reported thereon through Col. J. J. Abert and Lieutenant-Colonel W. Trumbull, of that bureau, who said: "We think the plan as proposed by Mr. Childs practicable, there being an abundant supply of water in the summit lake alone, apart from other supplies below it; that no other route is so adequately supplied with water, and that the work could be done at the amount stated upon his exposition of quantities and labor."

The large interests held by ourselves in Nicaragua have rendered all projects for explorations to discover new routes of communication between the oceans of great importance, and they have received earnest consideration. But I desire to state, as the result of my steady attention to this subject for upwards of twenty years, that, so far as my knowledge extends, no interoceanic pass has been discovered which was not known to the old Spaniards and their cattle hunters, and was used by the Indian inhabitants of the continent in times preceding them—and they were not a barbarous people (as the magnificent ruins of their cities testify to this day), but a people who have left very important evidences of active communications with Central America, both from the north and the south. The conclusion is not unreasonable that no new route will be discovered.

The naval authorities at Washington, some years ago, expressed the opinion that the interoceanic canal, in width, depth and supply of water, in good anchorage and secure harbors at both ends, and in absolute freedom from obstruction by lifting locks or otherwise, must possess as nearly as possible the character of a strait, and the recent expedition to Darien sought in vain to discover these conditions. It is generally assumed now that they do not exist; and it is proposed to supply the deficiency of nature, and to pierce the mountain range by a tunnel on the ocean-level to be used by sea-going ships, the feasibility of which can only be decided when the fact shall be accomplished.

It is not certain that the Cordilleras are solid at their base ; they may be seamed with enormous caverns, caused by the upheaval of their gigantic mass. All reports so far agree that the structure of this portion of the great chain of the Andes is substantially a trap-rock formation, a submarine overflow from the bowels of the earth at different periods, which carried up with it boulders of granite mixed in its mass, and in its latest elevation above the ocean raised also much drift and alluvium. This trap-rock is too loose and separate in its parts to be useful for construction. Whether such a tunnel, if made, would support itself, is more than we can decide; who would, or could, guarantee its permanent safety?

The sober sense of mankind will avoid such desperate risks, which have not the recommendation of cheapness to offer as a compensation, and we must look to the system of above-ground water communications alone as they exist in Nicaragua.

The engineers who planned the different tunnels in the Darien and Panama canal schemes were driven to such contrivances by the contemplation of the practical impossibility of making a deep cut from ocean to ocean, which would have the desired character of a strait for ships to pass through on the ocean level.

We may except the scheme of M. de Lesseps, which has so recently been brought forward, for a canal on the ocean level. It has no tunnel to pass through, but a bottomless swamp, 12 miles long; also it requires a dam about a mile long and 150 feet high to hold up the waters of the Chagres river; likewise a tide lock at Panama, where the tide rises and falls 20 feet. His projected canal will only pass one ship at a time, and its cost is estimated by American experts at $400,000,000. On commercial principles such a scheme can hardly be entertained, but there may be political reasons of which we know nothing.

Theoretically, a tunnel of any length or size may be assumed as possible, but it by no means follows that because a tunnel through the granite of Mount Cenis, sufficiently large to pass a railroad carriage, is practicable, that a tunnel 160 feet high by 100 feet wide through the loose trap-rock mountains of Central America, sufficient for the largest ships to pass through, is practicable.

We are, for reasons before given, as well as for others concerning ventilation and navigation, compelled to reject all canal schemes having long tunnels, whether they be on the level of the ocean, like the San Blas, or high up in the air, with a more than doubtful water supply all the year round.

The line across Nicaragua, as surveyed and laid down by Childs, is free from the objection of tunnels, great or small, *and has at its summit a level of navigable water (from Castillo on the San Juan river to the first lock descending to the Pacific) of* 103 *miles without an impediment of any kind. This is a sea of fresh water at the summit,* 12 *feet lower than the reservoir in Central Park, City of New York, inexhaustible in quantity, and the rim which confines it on the Pacific side is only* 46 *feet high.*

In regard to the comparative cost of the construction of an interoceanic canal, the distance from ocean to ocean is reduced nearly one-half by the use of the San Juan river for 90$\frac{80}{100}$ miles, and costs only $12,528 a mile, according to the computation of Childs, to make it complete for service.

The artificial canal of Childs, leading from the San Juan river into Greytown harbor, 28¼ miles, being an earthwork altogether, costs $164,752 a mile, whereas the section work on the Pacific, 17¾ miles long, being mostly stone excavation, costs $439,372 a mile. The locks on the San Juan river cost, on an average, $248,246 each, and the dams $224,574 ; on the earth-canal the locks cost $245,265 each. On the Pacific side the locks cost rather less, averaging $224,572 each.

Fortunately, the amount of cutting at the summit, between the lake of Nicaragua and the Pacific ocean, is principally confined to a section five and a half miles long, with a summit elevation of 46 feet above the lake, about one and a half miles long; but this piece costs at the rate of a million dollars a mile.

The outflow of the San Juan river from the lake of Nicaragua, has worn a channel for our use which would have cost incalculable millions to remove by any process of art known to man. These estimates which have been made by Mr. Childs were based upon formal survey, and are accompanied by ascertained quantities of above-water excavations, and under-water excavations in the various earth, rock, gravel, clay and sand encountered between the two oceans, and the price of such excavations varies from $3 per cubic yard for submarine rock, to as low as $1.40 for rock work very favorably situated; but the principal rock excavations above ground are calculated at $1.60 per cubic yard, earth excavations generally at 35 cents per cubic yard, gravel and clay at $1.50 per cubic yard, and sand at 25 cents per cubic yard in gold, and the depth of the canal and its locks was for vessels drawing 17 feet. The entire work was estimated to cost $31,500,000. The same work well located in New York State would cost only $13,500,000.

The larger dimensions of the canal proposed by Mr. Menocal will probably bring up the cost of a 28-feet-deep canal to $55,000,000 as against $31,500,000 for the 17-feet-deep canal of Childs. I have great faith in the ability and good judgment of Mr. Menocal, which he has shown by his plan of carrying the canal from Greytown to a point above where the San Carlos river enters the Rio San Juan.

The harbor of Greytown, when I first knew it in 1850, was large, deep, and well sheltered, and was a favorite rendezvous for ships of war ; and the most ancient maps have this harbor laid down. We hear a great deal said about the moving coast sands, but the loss of the harbor was not brought about primarily from that cause. It was the result of a freshet of unusual force, which carried away a small island in the San Juan river, a little above the divergence of what is called the Colorado branch of the Rio San Juan, which allowed a large increase of water to pass down the Colorado branch, impoverishing just so much the current of water which heretofore formed the lower San Juan branch, and had sufficed to keep the entrance to Greytown harbor open and with sufficient water at the bar to admit the entrance of the largest ships.

With a powerful river like the San Juan in its rear, if the same means were adapted to deepen the harbor and its entrance which have been put in practice upon the mouths of the Danube and the Mississippi rivers, there would appear to be no reasonable doubt that Greytown harbor may again be made available for the purposes of commerce and especially for the entrance of the canal. The San Juan, the Danube and Mississippi discharge their waters into almost tideless seas, and the depth of water on the bars of the Danube and Mississippi has been more than doubled by the simple process of embankments and jetties. It is a question of cost; but if the engineers of the Nicaragua canal should decide, after fully weighing its probable results, that such method should not be undertaken, and that an artificial entrance to the canal by means of piers or jetties outside of Greytown harbor is the best for so vast a work as the canal, it seems to me a very weak objection to the plan that the piers may possibly require to be lengthened at certain times when the supposed drift of the sands along the coast shall reach the mouth of the pier entrance and threaten to obstruct it. Allowing for the sheer possibility of this action of the sands, it must be reckoned as one of the standing expenses of the canal to provide a fund to lengthen the piers.

The Suez canal is most likely the reopening of a navigation which in very ancient times united the Red Sea and the Mediterranean. Africa was then an island, and Egypt did not exist. The Nile having its sources under the equator, created Egypt, and the mud of the Nile, passing out to sea, was carried easterly by the Mediterranean current, and thus gradually filled up the waters which separated Africa from Asia, and formed the Isthmus of Suez.

The same process is going on to-day, and the piers of the Suez canal will have to be lengthened from time to time, because the Nile mud-deposits always did and always will be formed about the entrance of that canal.

The great trade of our isthmus canal will probably be the coasting trade of the United States, and the direct trade of California and Oregon with Europe.

Who can measure the future of the west coast of this continent, or assign limits to the intercourse of mankind, the moving to and fro of nations, and the living activities which Asia, awakened from her slumber of thousands of years, must infallibly call into life? Where is the limit of the probable? Ask the experience of the past, and it will tell you that the facts of our own day far exceed the stretch of the most sanguine expectations of our youth—and so to the future will the doings of our times appear insignificant compared with the facts of our next generation, and in nothing so clearly and demonstrably as in the *movement* of mankind, the increased wants of civilization and the means of supplying them, of which the interoceanic canal will be the most illustrious fact.

Why subject this trade for all time to the unnecessary burden of an additional distance of seven hundred miles by any of the routes which end in the Bay of Panama? They are all too far south for the interests of the United States.

If the Nicaraguan route should cost twice as much as any of the Panama routes, it would be better to build the canal by the way of Nicaragua, even at that cost. Instead of this, the estimated cost of the Nicaragua canal is scarcely half the cost of any of the Panama Bay routes, and not one sixth of the costs of M. de Lesseps' projected canal.

In regard to the proper location for the interoceanic ship canal, have we any room to doubt? The white clouds which cling like pennants to the lofty top of Mount Ometepec, proclaim to the nations of the world, "This is the gate of the two oceans."

Upon the conclusion of Mr. Body's remarks,

Judge DALY said: All the routes have been examined during the four sittings of the Society, with the exception of the Panama route. Mr. Appleton expected to be present at the last meeting, but he was unexpectedly called to Boston and has not returned. I received a letter from him yesterday, in which he expressed his strong desire that there should be a full exposition of the merits of the Panama route, and he suggested that, as he was unable to be present, Commodore Mead, who has just returned from Panama, might come here to-night and give us an account of the Panama route. I sent a messenger to Commodore Mead with Mr. Appleton's letter, but the Commodore stated that, as he was acting for the government, he did not feel at liberty, at present, to make any statement that might be published. We therefore need an exposition of the Panama route to enable us to complete the subject.

I do not know that we shall sit again. The investigation has been very exhaustive ; and as everything that has been said will be recorded and will be printed, I think we shall have a very full presentation of the views entertained of all routes, except that by way of Panama. On that route we can say that we have a great many objections recorded against it from gentlemen who favor other routes. But it is desirable that the Panama route should have some advocate here, one fully acquainted with it, prepared to answer the objections made against it, if they are answerable. I shall take occasion before the proceedings are published to communicate with some gentlemen who favor that route, in order to obtain such an account of it as they may be willing to furnish.

I received a letter from M. de Lesseps before his departure from Europe, stating his intention of coming to this country and visiting this city, which I suppose he will do after he has finished the inspection of the Panama route. It was intimated at the first meeting, at Chickering Hall, that he would be invited to meet this Society. We propose to give him a public reception upon his arrival here, either at our house or at Chickering Hall, where a large number of members can assemble to receive him, and hear from him such an exposition as he may desire to give. As a distinguished citizen of the world, who has conferred great benefit upon mankind by the opening of the Suez canal, who has accomplished one of the extraordinary enterprises of this age, we propose to have our reception personal, leaving him to address the Society if he chooses to do so upon the subject of the Panama route. I have corresponded with him during the progress of the building of the Suez canal, and I can say that certainly as many objections were raised to that route, and as many statements made of the impossibility of its accomplishment, as have been made to any of the routes that have been discussed during these sittings. The Suez canal was pronounced impracticable from almost all quarters, and various reasons were suggested why it would prove so ; most of which proved to be unfounded, and some of which were very serious, but were ultimately overcome; and Monsieur de Lesseps enjoys very great triumph in the success of the enterprise which he undertook almost single-handed, and for the wonderful way in which he enlisted the pecuniary aid necessary to the performance of the work.

I but express the feeling of the Society when I thank the gentlemen who have discussed these questions. With the exception of Mr. Body, who is an old member of the Society, I believe they have not been connected with it; they have been engineers, who have discussed it from a practical point of view. We are very much indebted to them, and I think the commercial world will consider itself indebted to them for they have given us practical views of men entitled to be heard.

We have Mr. Kelley with us to-night, and I asked him whether he had anything that he would like to say upon the subject of the San Blas route. Mr. Kelley, I believe, has spent over $100,000 in getting up surveys of the isthmus, a matter of private enterprise, and he is entitled to the thanks of the commercial world and especially of this country.

Judge Daly then introduced Mr. Kelley, who spoke substantially as follows:

Mr. KELLEY said: My plans have been discussed so much that it seems to me hardly worth while to say anything. My friend Major Shelbourne handled the subject much better than I could, and I could only go over the same ground.

My effort has been to find a canal practicable, without locks, and I believe that is the only manner in which it will be built. In my judgment the San Blas is the best route of all, because it is the shortest route. Short lines are what the commercial world want —quick lines. Ships want to go through on an even keel; they do not want delay; they want harbors already made; they want harbors that are natural and that will remain open naturally, with no necessity for dredging to keep them open. Ship captains and shipping merchants in this country and in Europe are all agreed in this respect. On the San Blas route the total distance through is 30 miles, 10 of which is the river Bayano, almost suitable for navigation, and of the remaining 20 miles, seven is a tunnel. That is the only spot that I can see anywhere on the isthmus that a sea-level canal can be built. It is only a question of time when the commerce of the world will demand a deep, wide cut through the shortest part of the isthmus. A canal by way of Tehuantepec or Nicaragua will not satisfy commerce. Large ships of from 4,000 to 7,000 tons burden will not cross that isthmus through locks required to be 400, 500 or 600 feet long and constantly liable to get out of order. The question is not so much one of cost as of convenience and facility. What are $30,000,000 or $50,000,000 more or less in a work of this kind, which is to last forever, and accommodate the ever-expanding needs of trade. The world has the money ; there is enough to build this canal if it should cost $200,000,000. The state of New York has spent more than that amount in public improvements. What are $150,000,000 for the world ? There is a great deal in having a canal that will be economical to maintain when finished. A canal must have something besides dirt to line its embankments. No dirt embankments will stand in that climate without walling. If the canal is 60 miles long, you must have 120 miles of something besides dirt for embankments. The Atrato river has natural embankments, the growth of ages, but they are like sieves, and hold no water. That is the same with the banks on Nicaragua or at Panama. Wherever a canal is built, there must be stone embankments or something besides dirt which the rains of a night will wash away. Those who have figured estimates have not included this expensive item. All are interested in making their estimates as low as possible. You cannot build a canal through Nicaragua 28 feet deep and 125 feet wide for less than $125,000,000. Of course you can build a small-boat canal there for less money. But we are not talking of that—we are talking of a ship canal large enough to satisfy the commerce of the world for all time. From all the late surveys, the least quantity of material to be removed is on the Napipi, and next to that comes the San Blas route. A tunnel 80 feet wide at the water surface and 140 feet high above the canal bottom to crown of arch is sufficient. You can have it a little higher, or a little lower, if you please; that is merely a matter of convenience. Eighty feet in the tunnel is wide enough for one vessel. A ship can pass this route in ten hours, towed at the rate of three miles an hour; 100 ships can pass from one ocean to the other in 10 hours and 100 back, making 200 in 24 hours. No other route will furnish such facilities. The heading in the tunnel, of which there are 332,642 cubic yards, is estimated at

$20 a cubic yard; break-down, containing 10,090,080 cubic yards, at $5; open-rock cutting, 15,011,219 cubic yards, at $1.50 to $2.50; earth excavation, 3,995,895 cubic yards, estimated from 50 to 75 cents a cubic yard; masonry, amounting to 54,446 cubic yards, estimated at $15 a cubic yard; concrete, $7; pumping, 2,500,000; and the total cost of the canal finished from ocean to ocean, including 25 per cent. for contingencies, would be $104,017,780. If the tunnel should require lining, its entire length, which the firm character of the rock does not indicate, then about $30,000,000 additional would have to be added to the above sum. The total quantity of material to be removed on the entire line would be 29,389,828 cubic yards, of which 25,543,939 cubic yards is rock—the safest, best and most reliable material out of which you can construct the canal; the remainder is earth—nearly 4,000,000 of cubic yards. So we have 25,000,000 yards of rock and something over 3,000,000 cubic yards of earth. The harbor of San Blas, on the Atlantic side, is excellent. Of it, Commander Selfridge says that "San Blas has a most magnificent bay, with deep passage and fine anchorage, perfectly protected from the north winds. In the northwest corner is an inner harbor, formed by a circle of islands, with a passage leading into it a mile wide, capable of holding easily all the shipping of an immense traffic." There is not a blow to be struck in that harbor, not a single dollar to be spent on it, except to put up light-houses. These are the kinds of harbors we want for a ship canal—natural harbors, which ships can reach at all times—harbors that are not constantly filling up, and that, in order to keep open, it will be necessary to dredge as long as the world exists.

A member of the Society said that the speaker had referred to a canal without locks, but it was understood that the tide in the Bay of San Blas, on the Atlantic side, had less than two feet of rise while on the Pacific side the rise was 22 feet. He inquired how Mr. Kelley proposed to overcome that without locks.

Mr. Kelley: Latterly the discussions have been in the papers and before the Paris Congress of a canal "without locks." This is not a proper term. The proper term is a "sea-level" canal. But no lift lock will be required. The tide rises on the Atlantic side from 18 to 24 inches; it rises in the Bay of Panama from 12 to 18 feet. To overcome that difficulty we have to place a tidal lock on that side of the isthmus.

Now, I wish to call your attention to one point: the only practicable route that exists anywhere on the isthmus, without a lock-gate, a dam, or any obstruction is the Atrato and Truando route.

[Mr. Kelley here pointed out the lines of the Panama railroad, the San Blas route, the old Darien route, the Atrato and Truando route, the Napipi route, and the San Juan route.]

Mr. KELLEY continued: Baron von Humboldt states in his writings, that as early as 1788, a Spanish priest constructed a little canoe canal and at that early period bungos ascended the Pacific coast to the San Juan, ascended that river to San Pablo, and there their cargoes were discharged into small canoes, taken through that canal, then put into bungos, and a descent was made down the Atrato to the Atlantic ocean. He states that there was a water passage. We surveyed that route and such a passage never existed. Yet it is a remarkable statement, for it is the lowest summit that has ever been found. That statement made by Humboldt in his work on Central America is untrue; no canal ever did exist or could exist, for the reason that the headwaters of the Atrato are 102 feet above the San Juan, and the Atrato at that point has only canoe navigation, the San Juan having about 10 feet of water. If that had been the highest point, it might have been available but there is no water to feed it. My surveying parties were all through this valley during 1852, 1853 and 1854. I had it thoroughly explored, and the result is what I now state.

Judge DALY: What is your opinion in respect to the possibility of finding any lower summit level through the isthmus?

Mr. KELLEY: It is not possible at all.

Judge DALY: In other words, you think, if it had existed, the Indians would have found it out?

Mr. KELLEY: If there had been a low summit, in all probability the Indians would have found it out. What I mean is, no such thing as a dead level exists anywhere on the isthmus. The summit of the Panama railroad is the lowest summit, and that is 290 feet above the level of the sea. The San Blas summit is 1,500 feet above the level of the sea. It is not at all likely that any lower summit than 150 feet will be found. Entering the Atrato at the Gulf of Darien, we ascend it for a distance of 67 miles, and on reaching its junction with the Truando we are 20 feet above either ocean—a natural summit. From there we turn to the right, deepen and widen that stream by dredging, and make a through cut into the Pacific ocean at Kelley's inlet, the result of which would be that this great river would have two mouths, one discharging into the Pacific and the other into the Atlantic. At the point of separation, which would be the summit level of the canal, it is 20 feet above the mean tide of either ocean. The supply of water would all be drawn from the Atrato at that point. This is a grand river, 220 miles long. Two *Great Easterns* can float up the Atrato river at this point. Once the canal was made, the Pacific would have a flow out and in of 12 feet, and the Atlantic would have a flow of two feet. But never would there be an overflow of the 20-feet summit. That is why it is practicable without a lock. The waters of the two oceans never would unite on that line. That summit is just right to accomplish these results. But the objection to that route is that it is 131 miles long—an excess in distance of over 100 miles over the San Blas route. Again, the bars at the mouth of the Atrato must be improved by a system of dredging or jetties, or some other plan to clear away obstructions. In the third place, there is a harbor to be created on the Pacific side. The probabilities are that the immense quantity of silt passing out of this river would create another sandbar which would give considerable trouble. By way of San Blas the harbors are natural; it is only 30 miles long, and we are out of the reach of the enormous flood of waters that would be met on the Atrato.

Being interrogated as to the climate, Mr. Kelley said it was bad throughout the whole isthmus—the Nicaragua, the Panama, the San Blas and the Atrato regions were all about the same in the matter of climate, but the Pacific side of the isthmus was much the drier, and there was the longest slope of open cutting in the San Blas canal, which was a great advantage.

Capt. Jenkyns C. Battersby then made a few remarks, in which he deprecated the building of a canal or the projection of any route along a water-course, on account of the danger from sudden and excessive freshets, saying that the safety and perpetuity of such a work would be proportionate entirely to the amount of rock through which it might be cut.

Adjourned.

ESTIMATES FOR A SHIP CANAL, RAILROAD, ETC., ACROSS THE ISTHMUS OF PANAMA.

By HENRY TRACY, Civil Engineer.

[From the original deposited in the Society, by CHARLES M. TRACY.]

The surveys made under your direction being limited, I have used the best information I could obtain from a personal examination of the valley of the Chagres river between Cruser and Chagres, and a part of the route from Panama to the mouth of the Rio Obispo. As the entire distance from Panama to the mouth of the Rio Obispo has not been measured, I have assumed it at 195 miles, which probably will not vary more than two miles. The distances in the Rio Chagres are taken from a traverse of it, which I made by floating down the stream in a boat, taking the time of passing various places, and occasionally trying the velocity of the current.

The following table gives the distances from Panama to the mouth of the Obispo and thence along the Chagres river to its mouth :

TABLE OF DISTANCES.

		Total.
Panama to summit	9 miles	9 miles
Thence to mouth of Rio Obispo	10 "	19 "
" " Gorgona	3 "	22 "
" " a bad sand-bar above Palanquilla	6 "	28 "
" " Palanquilla	6 "	34 "
" " Gatun	23 "	57 "
" " Chagres	5 "	62 "

The elevation of the surface of the ground at the summit was given me by Mr. Baldwin's levels at 330 feet above tide. I have made my calculations for this route (the one examined), though by no means certain that it is either the cheapest or the best route, or even that the lowest summit has been obtained.

From Panama to the summit the surface of the ground is undulating ; a part of this distance near the summit, the rock is near the surface of the ground, and, though easy to excavate, it will render the line rather expensive. The remaining distance to the mouth of the Obispo is in the valley of the Obispo river, in an alluvial soil, easy to grade. The valley of the Chagres river will also be comparatively easy to grade, with the exception of a few points where the hills crowd the route into the edge of the river. Of necessity the line will be rather crooked, but if a railroad be adopted none of the curves will be of so small a radius as to interfere with using locomotives.

There is necessity on this part of the route to have the embankments at least five feet above the highest known floods of the river, which sometimes in places rise 35 feet above low-water mark.

It is also necessary to have the whole line (if a road or railroad be adopted) well drained, and the bridges and culverts large enough to allow the great floods peculiar to the isthmus to pass off without doing injury.

The isthmus is so thinly populated that it is doubtful whether more than 150 laborers can permanently be obtained from the province at the ordinary rate of wages, viz., four reals Granadinos, or 40 cents a day. By raising the price to five reals, or 50 cents a day, 1,000 or 1,200 can be obtained from the provinces of Mumpox, Santamarta and Cartajena. If more are required it will probably be necessary to get them from some of the West India islands, and the price of wages will go up to six reals, or 60 cents a day.

The principal mechanics will have to be brought from the United States and the West India islands. Their wages, including all the expenses of transporting them, &c., can safely be taken at about double the ordinary price in the United States.

As the climate is always a hot one, and as the rainy season generally continues from the first of June to the first of December, and as during the remaining five months occur heavy rains, a man cannot do as much work there in a month as in the more temperate or dryer climates.

Taking all these circumstances into consideration, I have made an estimate of the cost of

I.—A ship canal from Panama to Chagres.

II.—A railroad.

III.—A plank road.

IV.—A turnpike or wagon road.

V.—A railroad from Panama to the mouth of the Obispo river, and making the Chagres river navigable by means of locks and dams to Panama, for steamboats 180 feet long, 48 feet wide (including wheelhouses), and drawing five feet of water.

VI.—A wagon road from Panama to the mouth of the Obispo river, and making the Chagres navigable as above.

I.—Estimate of the cost of a ship canal from Panama to Chagres, to pass vessels 350 feet long, 70 feet wide (in the clear), and drawing 24 feet of water:

19 miles of canal from Panama to the mouth of Rio Obispo, at $200,000	$3,800,000
15 miles of canal to Palanquilla, at $120,000	1,800,000
28 miles of canal to Chagres, at $100,000	2,800,000
60 locks, at $350,000 *	21,000,000
2 grand locks, at $300,000	600,000
Reservoirs and feeders to furnish the summit with water, say	2,000,000
Total	$32,000,000

N. B.—The canal to be, except in a few places, 250 feet wide on the surface and 26 feet deep.

II.—Estimate of the cost of a single-track railroad from Panama to Chagres:

GRADING.	
19 miles from Panama to the mouth of Rio Obispo, at $22,000	$418,000
42 miles from there to Chagres, at $18,000	756,000
SUPERSTRUCTURE.	
70 miles superstructure, at $12,000	840,000
Locomotives, cars, machine shops, depots, etc	186,000
Total	$2,200,000

N. B.—The distance for the railroad is put at 61 miles, or one mile shorter than the canal line.

III.—Estimate of the cost of a plank road from Panama to Chagres:

Grading from Panama to the mouth of Rio Obispo, 19 miles, at $4,000	$76,000
19 miles planked surface, 10 feet wide, 3 inches thick, with sleepers of 4 x 5, at $7,000	133,000

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* Note.—Each of these locks will require about 23,000 cubic yards of hydraulic masonry. The estimate is for plain, strong, but not finely cut, stone work.

Grading, Rio Obispo to Palanquilla, 15 miles, at $3,000	45,000
15 miles planked surface, at $7,000	105,000
Grading, Palanquilla to Chagres, 28 miles, at $3,000	84,000
28 miles planked surface, at $7,000	196,000
Total	$639,000

—say $650,000.

N. B.—The plank suitable for a plank road cannot be procured on the line of the road at this time for less than 50 cents to $1 each, as they are worked out by hand, and only a small portion of the population understand the business.

IV.—Estimate of the cost of a turnpike or wagon road from Panama to Chagres:

19 miles from Panama to the mouth of the Rio Obispo, at $7,000	$133,000
43 miles from there to Chagres, at $6,000	258,000
Total	$391,000

—say $400,000.

N. B.—This estimate is for a turnpike road to be graded generally 26 feet wide between the ditches, and gravelled except in a few places where gravel cannot be obtained ; in these places to be covered with broken stone so as to make a good, but not a macadamized, wagon road.

V.—Estimate of the cost of a railroad from Panama to the mouth of the Rio Obispo, and of making the Chagres river navigable for steamboats from there to its mouth:

Grading 19 miles of railroad from Panama to the mouth of Rio Obispo (as before given)	$418,000
23 miles superstructure, at $12,000	276,000
Locomotives, cars, machine shops, &c	100,000
5 locks and dams in the Rio Chagres, at $90,000	450,000
Clearing banks of river in various places, &c	26,000
Steamboat wharf and warehouse at Chagres	30,000
Total	$1,300,000

VI.—Estimate of the cost of a turnpike or wagon road from Panama to the mouth of the Rio Obispo, and of making the mouth of the Rio Chagres navigable for steamboats from there to its mouth:

19 miles turnpike from Panama (previously estimated)..	$133,000
Improving the navigation of the Chagres river (as previously estimated)................................	506,000
Total	$639,000

—say $650,000.

The estimates are in United States currency, and I think are abundantly sufficient to do the work on their routes. It is possible that it may be done for 15 per cent. less; but it is not very probable that it could be.

All of which is respectfully submitted, by

Your obedient servant,
Barranquilla, July 5, 1848. HENRY TRACY.

ADVANTAGES OF THE SUEZ CANAL OVER THE INTEROCEANIC CANAL AS A ROUTE FROM THE UNITED STATES TO CHINA, INDIA, &C.; WITH TABLES OF DISTANCES.

By JESSE YOUNG, Corresponding Member of the American Geographical Society.

These tables, which are as correct as the limited means at my disposal will allow of, will serve to show the relative distances between England on the one hand and New York on the other, and the principal ports of India, China and Australia respectively—that is, for steamers; for sailing vessels, the courses vary so much at different seasons of the year that no correct general idea can be obtained. From both England and America steamers will call at Gibraltar, Malta, Port Saïd, Suez and Aden for Bombay, and Point de Galle for Madras, Calcutta, Burmah, Singapore, Hong Kong, Shanghai, Yokohama; from Point de Galle for Australian ports, via King George's sound, Adelaide, Melbourne, Sydney, and New Zealand, though doubtless the distance to Australia in the course of a very few years will be materially shortened by vessels calling at Port Darwin direct from Aden, or more probably Locotra island, rounding Cape Guardafui, and discharging their mails, &c., to be forwarded to their various destinations overland, thus avoiding the much dreaded Cape Lewin. The distance from Point de Galle to Port Darwin being 3,120 miles, it thus makes the distance to Australia from England 9,856 miles, against 11,381 miles to Melbourne via Cape Lewin.

For eastern ports via the Panama route, vessels will coal at St.

Thomas, Panama, Honolulu, Yokohama, &c.; but for Fiji, New Zealand and the eastern ports of the Australian colonies, steamers will probably have to steam the entire distance of some 7,000 miles without coaling; this will prevent their being able to carry very much freight. It will be seen by comparing the distances, that with the exception of Japan, New Zealand, Fiji and the eastern ports of China, and the west coast of the Americas, Europe will derive no advantages whatever from the interoceanic ship canal, all other ports being nearer via Suez. For south Europe, even China, Japan and Australia (via Torres straits), are nearer via Suez, but I have taken England as a point of departure for all, it being one of the remote countries of Europe. Moreover, East African, Arabian Indian, Burman, Malayan, Javan, some Chinese and some Australian ports are nearer for the American commerce via Suez, than by way of Panama, or whatever route on that isthmus may be selected for a canal. The great advantage which the Suez canal will have over the Central American route, for all commerce with foreign countries where a canal is used, is the all important requisite of being able to coal at short distances, thus enabling vessels to carry a large amount of freight, and to take in fresh cargo and provisions at the numerous stopping places; none of these things can be done when a ship has to carry such an immense amount of coal for her own consumption. The traffic for sailing vessels would be comparatively small, judging by the number which now rounds Cape Horn, as against the number of twenty years ago.

Following are the distance-tables:

APPROXIMATE DISTANCES FROM LIVERPOOL.

	Via Suez.	*Via Panama.*
To Hong Kong	9,670	14,943
" Melbourne	11,381	13,195
" Melbourne (direct from Cape Guardafui, without calling at Ceylon)	11,000	
" Point de Galle	6,736	16,347
" Port Darwin	9,856	14,200
" Yokohama	11,290	13,323
" Panama, direct	4,593	
" Melbourne, via Cape Horn	13,290	

FROM NEW YORK.

	Via Suez.	*Via Panama.*
To Hong Kong	11,620	11,489
" Melbourne, via Galle	13,331	9,539
" Point de Galle	8,686	13,693
" Yokohama	13,240	10,869

From Panama to Honolulu	4,650
“ Panama to Sydney	8,000
“ Panama to Auckland	6,780
“ Panama to Fiji	6,240
“ Sydney to Fiji	1,693
“ Auckland to Fiji	1,095
“ New York to Gibraltar	3,250

STATEMENT BY COMMANDER SELFRIDGE, U. S. N., REGARDING HIS SURVEYS ON THE ISTHMUS OF DARIEN.

CHIEF JUSTICE DALY,
President American Geographical Society.

To the many communications on the subject of the piercing of the American isthmus that have appeared in the columns of your Bulletin, and in American newspapers, I have studiously refrained from adding, partly because I have never been officially connected with either of the present routes—Panama or Nicaragua—now prominent before the public, and partly because, from absence on foreign service, I have not had the opportunity of keeping pace with the discussion.

But in your issue of December 10, there appears a detailed report of a paper by Rear Admiral Ammen, read before the American Geographical Society, which might be styled a criticism upon the late International Congress, in which this gentleman goes out of his way to attack me personally; and, therefore, a further silence would be a tacit acknowledgment of his ungenerous remarks.

Quoting from the paper alluded to, Admiral Ammen goes on to say: “During the sitting of the Congress, I found myself frequently obliged to dissent from the propositions of Commodore Selfridge, U. S. Navy, who, *strangely enough*, was found in the Congress without being named by our Government.” The impression evidently intended to be conveyed is, that I had no right there. No doubt my presence was strange enough to Admiral Ammen, and a surprise to one who seemed, by his own admissions, to have had a good deal to do with whom should be sent to represent the United States. Admiral Ammen knew when he wrote this that I was, like himself, a member upon invitation of the French Geographical Society, issued through Baron de Lesseps, and, as such, was his equal in all the discussions of the Congress. My presence might have been strange enough to him, but to a Congress gathered for a general discussion of the subject the absence of one who surveyed or had been identified with all the routes covered by the Isthmus of Darien, would have been equally strange.

Admiral Ammen's insinuations that the Congress was gathered for an endorsement of the Panama route, is an insult to the many eminent men that composed it; and when it is remembered that of the two representatives of the United States both were avowedly in favor of Nicaragua, an inference equally uncharitable might be drawn.

The project of a canal via Nicaragua never stood any chance in the Congress, not because its opinion had already been manufactured, but simply because the idea is indelibly fixed in the majority of the French people that only a canal without locks can be a financial success, and Nicaragua does not admit of the construction of such a canal.

Many years ago, in a correspondence with Monsieur de Lesseps, he said to me frankly that no project which included the construction of locks could receive his approval.

Familiar with the Nicaragua route from the surveys of Mr. Childs, Commander Lull and Mr. Menocal, and with the Panama route from frequent passages across on the railroad, I have always been, and am still, of the opinion that the one known as the Atrato-Napipi is the more to be preferred.

In regard to my part in the Congress upon the discusssion of the latter, Admiral Ammen says: "I refer the curious reader to pages 66 to 70 inclusive, and to map 8, illustrative of the Atrato-Napipi as developed by Commander Selfridge. Nobody reading this report and referring to the drawings would suppose for an instant that the greater part of it was purely imaginary. It is delineated as an inclined plane, locks located, and sections given in figures! Between this fanciful presentation and the profiles made by Lieutenant Collins there is a very wide difference." Instead of this covert misrepresentation, Admiral Ammen should have had the manliness to tell the whole story. He knows the valley of the Atrato-Napipi was, previous to my visit, an unknown wilderness; that no maps or data were, or had been, ever collected. The survey alluded to was, therefore, as all surveys of an entirely new country must be, preliminary; and my plans were based upon such information as I obtained from this reconnoissance. He knew that entirely upon my representation the Hon. Geo. M. Robeson, then Secretary of the Navy, consented to send an expedition solely for the survey of the

Napipi valley, which, up to that date, time had not been afforded me to perform.

I had been many times to the isthmus, and, feeling that this service could be equally as well performed by Lieutenant Collins as myself, I asked that he might be ordered to take charge of it, and also requested that Lieutenants Eaton, Sullivan and Paine, able young officers, who had served with me upon all the previous surveys, might, with their consent, be attached to the expedition. I superintended its fittings, and Lieutenant Collins's instructions were drawn from memoranda suggested by my experience and knowledge of the route. The work was faithfully and ably performed by Lieutenant Collins and his associates.

Notwithstanding that the inception of a canal via the Napipi was mine own, that the peculiar characteristics of its construction had been worked out after long study, and correspondence with the first engineers of our country, Admiral Ammen, as then Chief of Bureau of Navigation, under the cognizance of which all surveys had been made, saw fit to ignore my previous participation in this work, and directed Lieutenant Collins to make out a report.

Then, finding that his obvious intention was to shut me out from any further connection with a route that I was the first to have explored, I procured all the data obtained by Collins, and, with the assistance of Lieutenant Eaton, made an entirely new calculation of the contents of the prism of the canal, and a change of location, as far as the last survey showed such to be necessary.

It was with a map and profile so prepared that I presented the Atrato-Napipi project to the Congress, taking care to lay before the "Commission Techinque," at the same time, the map and profile of Lieutenant Collins, and pointing out the only differences, which were in my avoiding a few of the elevations cut through by him, by straightening some of the numerous ox-bows of the Napipi, and availing myself of the low ground thus acquired. Admiral Ammen, who had never, if I am not mistaken, visited any portion of the American isthmus, except to cross at Panama, who lays no claim to be an engineer, has the hardihood to call these plans—based strictly, as he well knew (if he had taken the trouble to inquire), upon the information acquired by Collins—"purely imaginary and a fanciful representation."

In answer to such an accusation, flung out to the New York Geographical Society, of which I am a member, but unable, from absence on foreign service, to contradict till long after it had been made, I must be excused, in defense, for inserting the remarks of Mons. Lofebrere de Fourey, the president of the second "Sous Commission Technique," and the senior engineer of the Congress, as taken from the journal of the proceedings, at his speech in closing the discussion: "The project by way of the Atrato is one that has been rendered very enticing by the devotion of the man who has more especially occupied himself with this question. [Applause.] I believe I am the interpreter of the commission in saying that Mr. Selfridge will carry away with him the admiration of the commission, [applause] and I do not for a moment doubt that the entire commission will agree to the words with which I have expressed my high appreciation of the beautiful work of Commander Selfridge. [Prolonged applause.]"

A comparison of the rival routes of Panama and Nicaragua can only be made by applying a similar construction (namely, with locks) to each, for Nicaragua does not admit of any other. As to the sea-level canal at Panama, it will be better to await the personal investigation of Count de Lesseps, with the French engineers, and of Colonel Totten, whose long familiarity with this route makes him an authority beyond all question.

As to a canal with locks, I have no hesitation in preferring Panama to Nicaragua. In that we have a length of canal navigation of 48 miles, offset by one of 124 miles, not including the transit of Lake Nicaragua.

The great obstacles at Panama are the floods of the Rio Chagres, and to avoid them it does not seem necessary to carry the summit level higher up than the station known as Barbacoas, which would be about 60 feet above mean tide, requiring six locks against the lift of 107 feet in Nicaragua. A strong feature in favor of Nicaragua is that there are no very deep cuts in the route, as proposed, from which, at the same time, the Panama line is not entirely free. This is more than offset by the amount of under-water rock excavation required for Nicaragua. Besides, when a canal does not interfere with the natural channels of drainage, I am of the opinion that danger from rains merely can be averted by not very costly expedients.

It is alleged that the rainfall of Panama is very much greater than of Nicaragua. In the absence of any reliable measurements for the latter, and considering the fact that Aspinwall and Greytown are but $1\frac{1}{2}°$ of latitude apart, it is doubtful whether the difference, if any, would be material.

In advantage of harbors, Panama is far ahead. No doubtful results attach themselves to the security of Aspinwall by a simple breakwater, while the same at Greytown cannot by any means be said. In the facility with which all parts of the line can be reached, and supplies forwarded, the Panama is immeasurably ahead. In one case, steamers would unload at the wharfs of Aspinwall, and in a few hours distribute their supplies over the whole line; in the other, till a harbor was dredged and breakwater made, supplies must be landed on the beach, then transported, in the absence of a railroad, by carts, or by light-draught steamers over falls, for a distance of 100 miles or more.

In compactness of line, involving greater economy in construction, Panama is much superior.

It is alleged, in favor of Nicaragua, that its Pacific terminus is 600 miles nearer San Francisco. While this is true, it is wholly offset by the additional time it would take for the transit by Nicaragua, while the eastern termini of both are about the same distance from New York or Europe.

Lastly, against Nicaragua, it has, I think, been a reasonable objection, that the western portion of the proposed route passes through the most active volcanic region at present known. Much more might be said, but I will not trespass any further upon you.

It is to be regretted that the partisans of these two rival routes cannot reconcile their differences, and form an international company, under the leadership of such men as General Grant and Baron de Lesseps, the pride equally of their countrymen, which would command the confidence of the world. Such an organization, sending out a corps of engineers committed to no locality, blinded by no prejudice, would arrive at a result which the future could give no cause to regret.

THOS. O. SELFRIDGE, JR.,
Commander U. S. Navy.

U.S.S. "Enterprise," Athens, Greece,
Jan. 14, 1880.

OBJECTIONS TO THE ISTHMUS OF TEHAUNTEPEC AS A CANAL ROUTE.

Chief Justice DALY, *Pres. of the American Geographical Society.*

SIR,—At the time of the reading of my communication before your Society, Dec. 9, 1879, I invited its discussion by others interested in the question, and am glad that it has been considered at several subsequent meetings held at the Society's rooms. The discussion has taken somewhat broader grounds than I anticipated, in renewing debate upon a variety of projected routes which have been considered at various times within our memory, and has thus drifted away from the two which seem to me to be under discussion at this time. As I could not be present at these meetings, and have accepted the courtesy of your Society heretofore in communicating most of my views to those interested in the question, I think it proper to continue to avail myself of it in thus communicating what appears to me to be a succinct idea of what is likely to promote, and what to prevent, the construction of a canal, at least by an American company.

For some extraordinary reason, the Isthmus of Tehuantepec is again presented as a possible line of canal construction, and a survey of it is again proposed. Yet we know that it has a summit level of 754 feet, and will require 140 locks, or *seven* times the number of the Nicaragua canal ; it has a line of actual excavation of 144 miles, or more than double the distance on the Nicaragua line, and it has a proposed dredging of a river subject to floods for a distance of 35 miles.

It has also to draw its water by a feeder 27¼ miles long, requiring a dam 86 feet high to get the necessary elevation, having four tunnels aggregating 3¾ miles, and even then a deficient water supply.

By the report of Engineer Fuertes, of the Tehuantepec survey under Captain Shufeldt, page 26, the Corti river, at point A, Map No. 2, is stated as supplying 1,618 cubic feet per second, exactly the quantity required for the alimentation of the canal, as given on page 31. All the available streams were found to yield 2,113 cubic feet per second, or 490 feet more than required. He estimated the loss in the feeder filtration, evaporation, &c., at 550 cubic feet per second, thus making the delivery amount to 1,563 feet per second, making a deficiency of 55 cubic feet per second.

On page 31 he cites two examples of feeder losses. The St. Privé, 26,000 feet long, loses three-fourths of its water ; if loss at the same rate should occur, no water would reach through the seventh mile. In the example of the feeder of Boulet, which is 56,000 feet long, if loss at the same rate should occur, the water would not reach through the fourteenth mile. In the first case the water would reach one-fourth the length of the proposed feeder, and in the second case it would reach one-half of its length.

He states, however, that the nature of the soil along the Corti, or proposed feeder from it, is well calculated to prevent filtration, but in giving the different sections along the feeder, he mentions that some portions of the cutting and tunnelling are in shale and drift, or "humus and loose earth." In the fifth division there is a tunnel two miles long, which, he says, "can be easily excavated, the ground being very soft." On some portions of the feeder, he states the formation to consist of clay, sandstone, marble and compact limestone.

There are numerous proposed dams for the interception of small streams crossing the line, and an aqueduct 1,200 feet long. Throughout several miles of its course, the feeder is raised above the natural surface, a condition favoring a large loss through filtration.

The cost of locks at the same estimate of the Nicaragua route would be $50,000,000; of actual excavation, $45,000,000; of feeder on Panama route—none being required via Nicaragua—$25,000,000; then the excavations of the Coatzacoalcos river for thirty five miles would sum up probably $5,000,000. The estimated cost on the upper San Juan, and $5,000,000 more, as in Nicaragua, for harbors presenting the same difficulties, make a total of $130,000,000.

The commission appointed by the President, of which I was a member, instead of adopting the estimate of 25 per cent. of the engineer to cover contingencies on the Nicaragua route, thought it necessary to double the estimates, and that too where building materials of all kinds were abundant and convenient. There is still greater reason to double the estimate of the Tehauntepec route, making it $260,000,000, and that too, as is shown, *without a water supply* adequate, at least, during the dry season.

Another survey cannot materially change the summit level already determined; it cannot change the length of the canal; it cannot add to the water supply without an increase in the estimate; it cannot, by any means, change the relative disadvantages which unhappily exist in its comparison with Nicaragua. What then is the purpose —what the object of a survey? Certainly there is not the faintest hope of those who are informed that the conditions will be found materially different from the above statement, whatever the assertion may be.

The Nicaragua route has in canalization 61¾ miles; the remainder is either lake or slack-water navigation in a river not subject to floods; the water supply is twenty times more than could be used in lockage; the summit level of the canal, 107 feet, and of the divide between the oceans, 150 feet. The cost of the canal, as estimated by the civil engineer, without an allowance for contingencies, was $52,000,000, and the cost named by the commission, $100,000,000.

The Panama route was carefully located at the request of the commission, and a line located at an elevation of 123 feet above the ocean, which will probably require an increase of four or five feet, as shown by the flood of last November. The cost of the last-named route, on a common basis for labor and materials with Nicaragua, was more than 50 per cent. greater, and will, in fact, cost more than double to execute.

It would doubtless be interesting to the public, and advantageous, to have the two last-named routes passed over by able engineers, with the instrumental surveys in hand, to approximate the relative cost of execution. To include the Tehuantepec route would be to include what is simply impossible of execution, by reason of the physical conditions above named. The object could not be to hope to make a canal there, but simply to prevent its execution elsewhere.

At this time there are in Nicaragua two European parties who are asking a concession. In March last, one was agreed upon to M. Blauchet, and only lacked one vote in the senate to confirm it.

The problem then is, shall we place no obstacle in the way of an American company, and thus probably enable it to secure a grant, with the idea of only permitting tolls that would be liberally remunerative, or, shall we place these obstables in the way, and certainly throw the concession into the hands of Europeans, and allow them to impose their proposed tolls upon us?

They may very well say that we are not *compelled* to pass through the canal; it is simply optional whether we go that way or *via* Cape Horn. We cannot very well propose to dictate what these tolls shall be, at least, unless we do so in advance of the granting of a concession by Nicaragua, and even then it would seem somewhat pretentious, in view of our inability to support such a demand, either in reason, or by material force.

I may add, that the commission appointed by the President in 1872, which sent in its report in 1876, had all of the information thought necessary respecting all the region involved. In short, the only two routes worth looking at are Panama and Nicaragua, and then only to establish the relative approximate cost of execution.

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